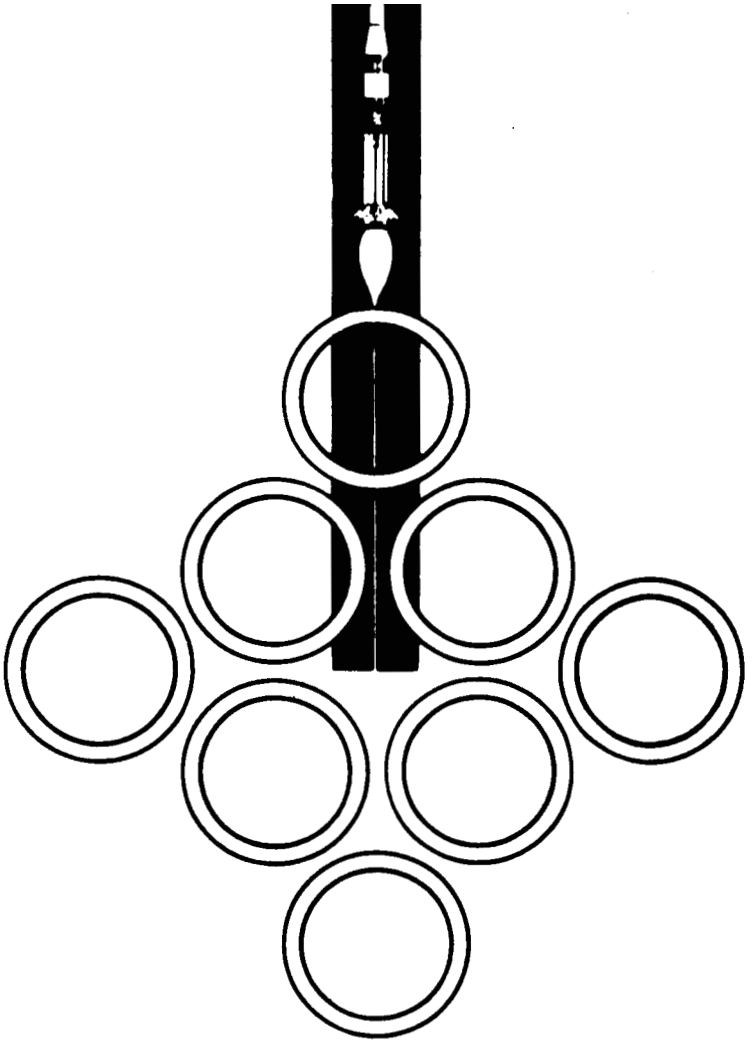


ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1064-3

December 19, 1966

SATURN IB PROGRAM

TEST REPORT
FOR

PNEUMATIC CYLINDER, DOUBLE ACTING

Pneudraulics, Inc., Model 7091

NASA Drawing Number 75M06911 Rev. D

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT
FOR
PNEUMATIC CYLINDER, DOUBLE ACTING

Pneudraulics, Inc., Model 7091
NASA Drawing Number 75M06911 Rev. D

ABSTRACT

This report presents the results of tests performed on two specimens of Pneumatic Cylinder 75M06911. The following tests were performed:

1. Receiving Inspection
2. Proof Pressure
3. Functional
4. Low Temperature
5. High Temperature
6. Surge
7. Vibration
8. Sand and Dust
9. Cycle
10. Salt Fog
11. Burst

The performance of each test specimen was in accordance with the requirements of NASA Drawing 75M06911, Rev. D, throughout the test program with the following exceptions:

1. Switch malfunctions after vibration and cycle testing of specimen 2 (SN 0002).
2. Switch malfunction of specimen 1 (SN 0017) after sand and dust testing.
3. Excessive leakage from each end of specimen 2 during functional testing.
4. Excessive leakage past the piston on the extend end during functional testing (at low temperature) of each specimen.

NOTE:

Switches on each end of the cylinder have a manual override in the blockhouse such that switch malfunction does not affect launch capability.

Specimen 2 was disassembled following the surge test and new seals were installed on the piston. Leakage was thus reduced to the specification allowable prior to vibration, life cycle, salt fog and a second low temperature test. Leakage during the post low temperature functional test was within specification limits.

TEST REPORT
FOR
PNEUMATIC CYLINDER, DOUBLE ACTING

Pneudraulics, Inc., Model 7091
NASA Drawing Number 75M06911 Rev. D

December 19, 1966

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

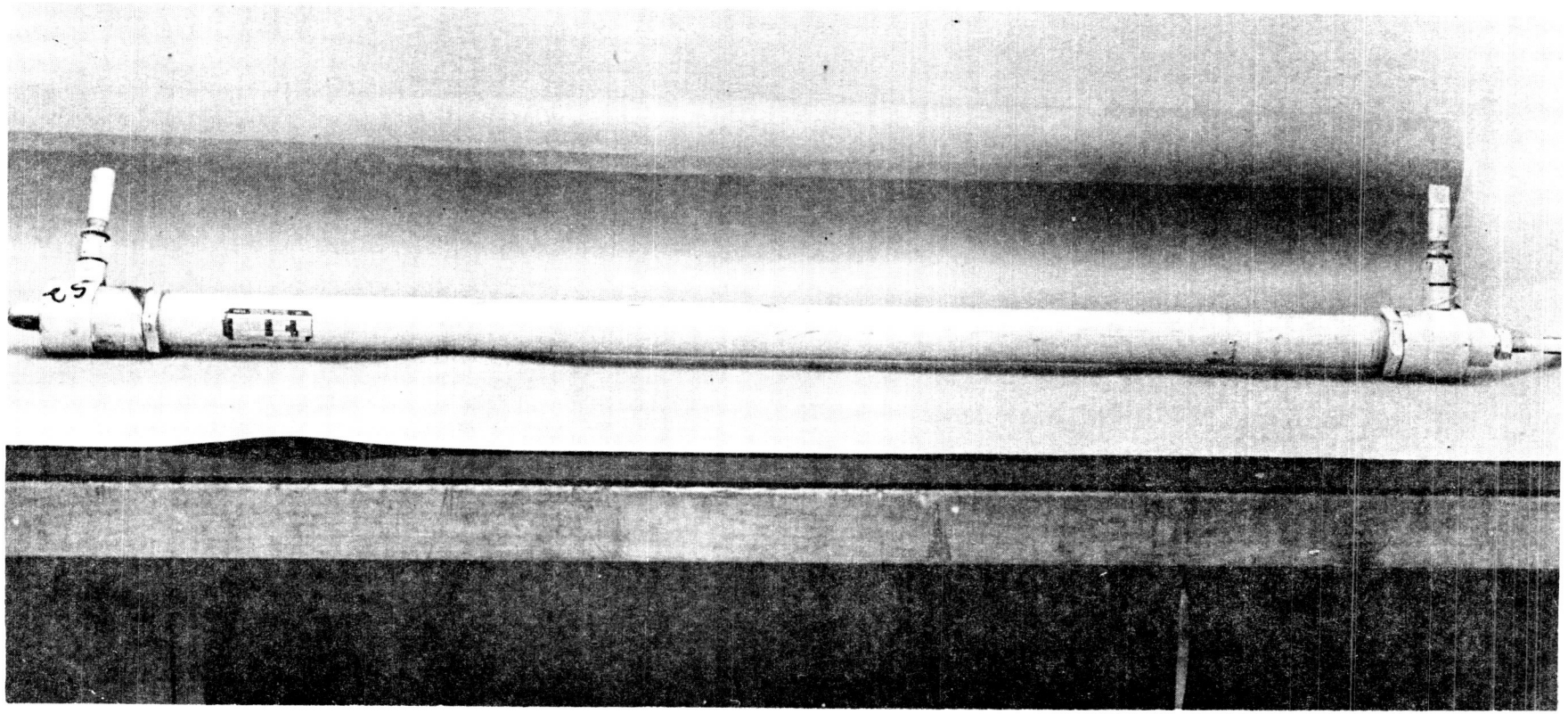
The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS8-4016, Part VII, CWO 271620.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF TABLES (Continued)



Pneumatic Cylinder, 7506911 Double Acting

CHECK SHEET

FOR

PNEUMATIC CYLINDER, DOUBLE ACTING

MANUFACTURER: Pneudraulics, Inc.
MANUFACTURER'S MODEL NUMBER: 7091
NASA DRAWING NUMBER: 75M06911 Rev. D
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A.	OPERATING MEDIUM:	Dry air or gaseous nitrogen
B.	OPERATING PRESSURE:	1000 psig
C.	LEAKAGE:	5 scim
D.	PROOF PRESSURE:	2000 psig
E.	BURST PRESSURE:	4000 psig (minimum)
F.	PNEUMATIC CONNECTIONS:	AND10050-4
G.	ELECTRICAL SWITCH:	Metals and Controls P/NAT91 NASA Drawing 75M13058-1
H.	INTERNAL LOCK:	Retracted position
I.	UNLOCKING PRESSURE:	50 ($\pm$10) psig
J.	MOUNTING ATTITUDE:	Any position

II. CONSTRUCTION

A.	CASE MATERIAL:	17-4 PH stainless steel per AMS 5643 condition H
B.	CYLINDER HEADS:	2024-T6 AL Alloy per QQ-A225/4, or equivalent
C.	FINISH:	All outside surfaces - steel, 5.4.1 and 22.2 of ML-STD-171, color No. 13655 (yellow) per FED-STD-595. Aluminum, 7.1.1 +22.2 of MIL-STD-171, color No. 13655 (yellow) per FED-STD-595.
D.	SEAL MATERIAL:	MTP-M-S&M-M-M-61-7 type MIL-P-5315 or MIL-P-5516
E.	LUBRICATION:	KEL-F-10 or DC 55

III. ENVIRONMENTAL CHARACTERISTICS - MANUFACTURER'S SPECIFICATIONS

A.	OPERATING TEMPERATURE RANGE:	0 to + 160°F

IV. SPECIAL REQUIREMENTS

A.	AGE CONTROL SPECIFICATIONS:	MSFC-STD-105
B.	PACKAGING SPECIFICATIONS:	MIL-P-116C, method 11F (No contact preservation required)

C. CLEANING SPECIFICATIONS: 10M01671, level VI

V. LOCATION AND USE: Used in the Apollo access arm to control the position of the escape tower hooks at John F. Kennedy Space Center Launch Complexes 34 and 37B.

TEST SUMMARY (Sheet 1 of 3)

PNEUMATIC CYLINDER, DOUBLE ACTING

75M06911

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Proof Pressure Test	2	2000 psig	Check for leakage and distortion	Satisfactory	No leakage or distortion
Functional Test	2	750 psig 1000 psig	Determine locking and unlocking pressures. Check for leakage	Specimen 1 satisfactory; Specimen 2 over 5-scim leakage	Average unlocking leakage for specimen 2 was 161 scim. Average locking leakage was 154 scim
Low Temperature Test	2	5(+0,-4)°F	Determine if specimen operation is impaired by low temperature	Leakage in specimen 1 and specimen 2 was over 5 scim	Average unlocking leakage for specimen 2 was 1190 scim. Average locking leakage was 1385 scim. Average unlocking leakage for specimen 1 was 113 scim. Average locking leakage was 4.0 scim
High Temperature Test	2	160(+4,-0)°F	Determine if specimen operation is impaired by high temperature	Specimen 1 satisfactory; Specimen 2 was over 5-scim leakage	Average unlocking leakage for specimen 2 was 8 scim. Average locking leakage was 7.8 scim
Surge Test	2	0 to 750 psig within 100 milliseconds 1000 cycles	Determine if specimen operation is impaired by surge	Specimens 1 and 2 satisfactory	New piston seals were installed in the cylinder of specimen 2.
Vibration	2			Specimen 1 - satisfactory	During sinusoidal scan vibration in the X-axis for specimen 2, the switch on the extend side of the cylinder failed to operate.

TEST SUMMARY (Sheet 2 of 3)

PNEUMATIC CYLINDER, DOUBLE ACTING

75M06911

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Resonant Frequency Search	2	5 to 65 cps at 0.01-in. DA displacement 65 to 2000 cps at 2.0g peak	Determine if specimen operation is impaired by vibration	Specimen 2 inoperative switch	
Sinusoidal Sweep	2	10 to 65 cps at 0.01-in. DA displacement 65 to 2000 cps at 20g peak			
Random	2	10 to 2000 cps at 0.05 g^2/cps			
Sand and Dust	1	4 hours exposure to sand and dust	Determine if specimen operation is impaired by sand and dust	Specimen 2 inoperative switch	During the functional test, the switch on the retract side of the cylinder failed to operate. The switch was disassembled, cleaned, and adjusted. The switch then operated properly after reassembly
Cycle	2	5000 pressure cycles	Determine if specimen operation is impaired by cycling	Specimen 1 satisfactory Specimen 2 inoperative switch	At the completion of 3044 pressure cycles on specimen 2, the switch in the retract position failed to operate. Both switches were disassembled, cleaned, and adjusted. The switches then operated properly after reassembly

TEST SUMMARY (Sheet 3 of 3)

PNEUMATIC CYLINDER, DOUBLE ACTING

75M06911

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Salt Fog	1	240 hours exposure to an atomized salt solution	Determine if specimen operation is impaired by salt fog	Satisfactory	Test completed
Burst	1	4000 psig (minimum)	4000 psig for 5 minutes 10,000 psig or until rupture occurs	Satisfactory	During the burst test at 7700 psig, the switch on the retract side of the cylinder began to leak. The test was continued to 10,000 psig, at which time the test was discontinued. No distortion occurred

SECTION 1

INTRODUCTION

1.1 SCOPE

This report presents the results of tests performed to determine if Pneumatic Cylinder 75M06911 meets the operational requirements for John F. Kennedy Space Center Launch Complexes 34 and 37B. A summary of the test results is presented on page x.

1.2 ITEM DESCRIPTION

1.2.1 Two specimens of Pneumatic Cylinder 75M06911 were tested. The pneumatic cylinder is used on the Apollo access arm installation to control the position of the escape tower hooks.

1.2.2 The cylinder is 54.42 (±0.060) inches long (retracted) and has a 1.56-inch-diameter bore with a 46-inch stroke. The cylinder is constructed of stainless steel per AMS 5643 condition H and is rated for use with air or nitrogen at an operating pressure of 1000 psig. The cylinder is locked in the retracted position and requires 50 (±10) psig to unlock.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Pneumatic Cylinder 75M06911.

a. KSC-STD-164(D), dated September 17, 1964, Standard Environmental Test Methods for Ground Support Equipment Installations at Cape Kennedy

b. NASA Drawing 75M06911 Rev. D

c. Cleaning Standard 10M01671

d. Test Plan CCSD-FO-1064-1R

e. Test Procedure CCSD-FO-1064-2R

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

Test specimens 1 and 2 (S/N 0017 and 0002, respectively) shall be visually and dimensionally inspected for conformance with NASA drawing 75M06911 revision D and applicable specifications to the extent possible without disassembly of the test specimen. The specimen shall also be inspected for poor workmanship and manufacturing defects.

2.2 TEST PROCEDURE

A visual and dimensional inspection of each specimen was performed to determine compliance with NASA drawing 75M06911 revision D and the applicable vendor drawing to the extent possible without disassembly of the test specimen. At the same time the test specimens were also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimen complied with NASA drawing 75M06911 revision D. No evidence of poor workmanship or manufacturing defects was observed.

2.4 TEST DATA

The data presented in table 2-1 was recorded during the inspection.

Table 2-1. Specimen Specifics

Name	Pneumatic Cylinder, Double Acting
Model	7091
Length	54.42 inches (retracted)
Bore	1.56 inches
Stroke	46 inches

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

Test specimens 1 and 2 (S/N 0017 and 0002, respectively) shall be visually and dimensionally inspected for conformance with NASA drawing 75M06911 revision D and applicable specifications to the extent possible without disassembly of the test specimen. The specimen shall also be inspected for poor workmanship and manufacturing defects.

2.2 TEST PROCEDURE

A visual and dimensional inspection of each specimen was performed to determine compliance with NASA drawing 75M06911 revision D and the applicable vendor drawing to the extent possible without disassembly of the test specimen. At the same time the test specimens were also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimen complied with NASA drawing 75M06911 revision D. No evidence of poor workmanship or manufacturing defects was observed.

2.4 TEST DATA

The data presented in table 2-1 was recorded during the inspection.

Table 2-1. Specimen Specifics

Name	Pneumatic Cylinder, Double Acting
Model	7091
Length	54.42 inches (retracted)
Bore	1.56 inches
Stroke	46 inches

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

The pneumatic cylinders shall be pressurized with air or GN_2 to a proof pressure of 2000 psig. This pressure shall be maintained for 5 minutes and the cylinders shall be checked for leakage and distortion.

3.2 TEST PROCEDURE

3.2.1 The test specimens were installed as shown in figures 3-1 and 3-2 utilizing the equipment listed in table 3-1.

3.2.2 All valves were closed.

3.2.3 With the cylinder in midstroke position, both pressure ports were pressurized simultaneously to 2000 psig by opening valve 7 and adjusting regulator 4.

3.2.4 Each test specimen was subjected to the proof pressure for 5 minutes.

3.2.5 The pressure was removed by adjusting regulator 4, closing valve 7, and opening valve 3. Each test specimen was examined for structural deformities.

3.3 TEST RESULTS

The test specimens did not leak, and there was no evidence of distortion.

3.4 TEST DATA

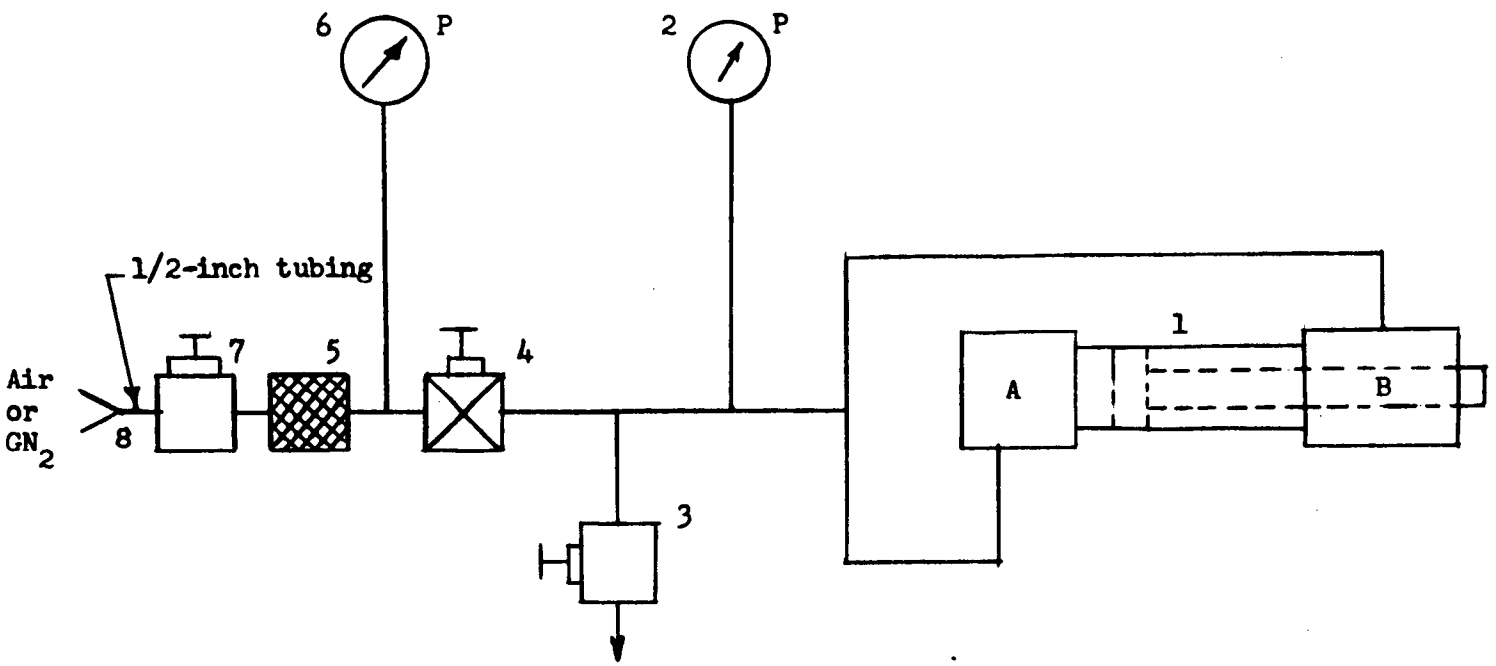
The data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	0002 and 0017	Pneumatic cylinder, double acting
2	Pressure Gage	Heise	NA	H40172	0-to 3000-psig ±0.25% FS accuracy Cal. date 6-24-66
3	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent
4	Regulator	Tescom Incorporated	26-10-21-20	3025	0-to 3000-psig
5	Filter	Bendix	1731261	NA	2-micron absolute
6	Pressure Gage	Heise	NA	H35960	0-to 5000-psig ±0.25% FS accuracy Cal. date 6-23-66
7	Hand Valve	Vacco	1600137-1	5116-6	½-inch
8	GN_2 or Air Source	CCMD	NA	NA	0-to 3500-psig

Table 3-2. Proof Pressure Test Data

Pressure	2000 psig for 5 minutes
Leakage	Zero
Distortion	None



Note: All tubing $\frac{1}{4}$ inch unless otherwise noted.

Figure 3-1. Proof Pressure Test Schematic

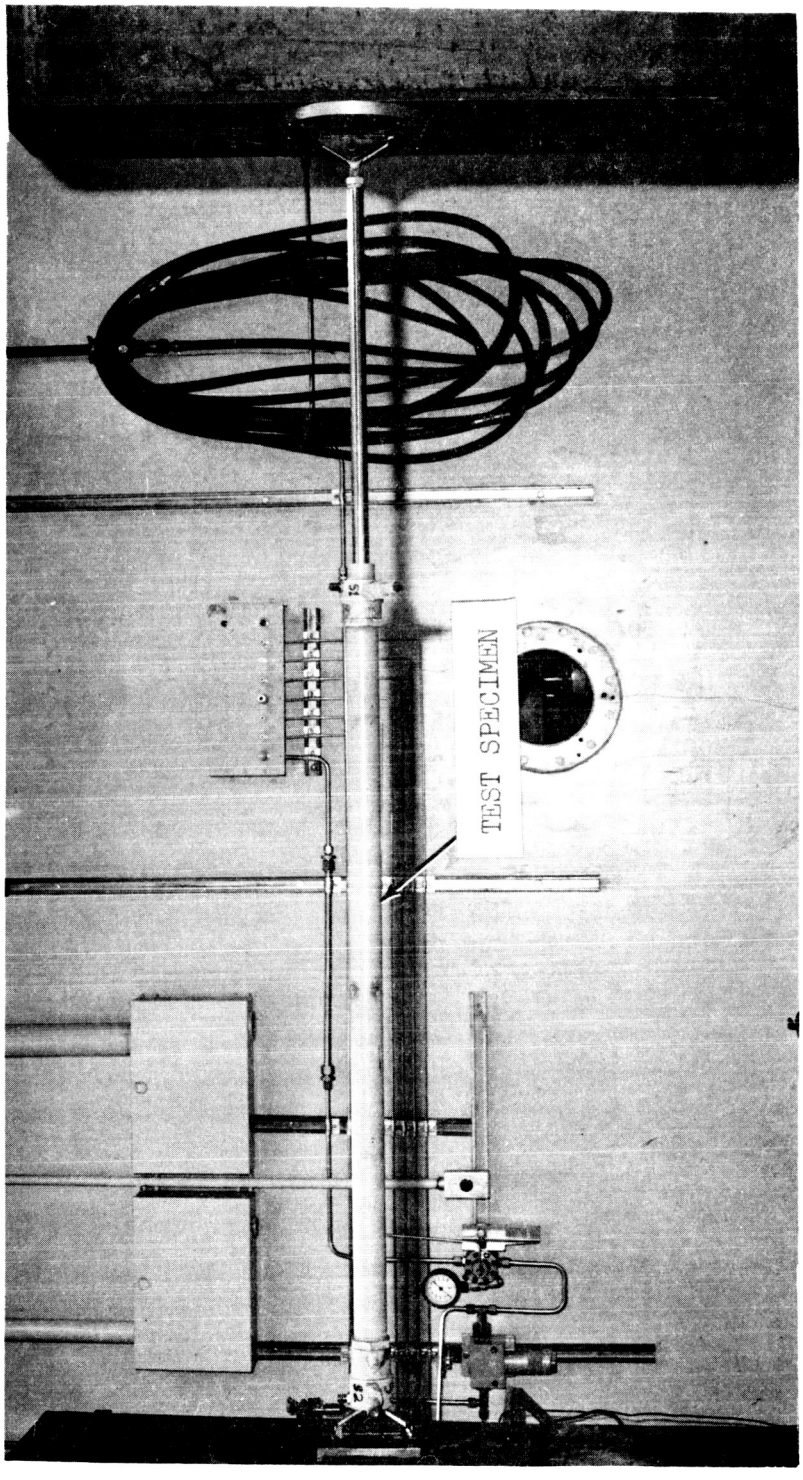


Figure 3-2. Proof Pressure Test Setup

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

4.1.1 A functional test shall be performed on test specimens 1 and 2.

4.1.2 The extend and retract ports of the specimen shall be alternately pressurized with GN_2 or air until the cylinder is fully extended or retracted. Ten cycles shall be performed on each specimen. The pressure required to unlock the switch, shall be monitored and recorded and the unlock switch indication shall be monitored. Unlock pressure shall be 50 ($\pm$10) psig.

4.1.3 The extend port shall be slowly pressurized to 750 psig and the retract port checked for leakage. Leakage shall not exceed 5 scim.

4.1.4 The step described in paragraph 4.1.3 shall be repeated except the retract port shall be pressurized and the leakage at the extend port and shaft seal shall be checked.

4.1.5 The steps described in paragraphs 4.1.3 and 4.1.4 shall be repeated using a pressure of 1000 psig. Leakage shall not exceed 5 scim.

4.1.6 Insulation resistance shall be determined between all non-connected terminals and between each terminal and the case. Minimum resistance shall be 20 megohms at an applied voltage of 500 vdc.

4.1.7 For all subsequent functional tests, the step in paragraph 4.1.2 shall be performed three times and the steps in paragraphs 4.1.3, 4.1.4, and 4.1.6 once.

4.2 TEST PROCEDURE

4.2.1 SWITCH INDICATION

4.2.1.1 The test specimens were installed as shown in figures 4-1 and 4-2 utilizing the equipment listed in table 4-1.

4.2.1.2 All valves were closed. Hand valve 15 and regulator 13 were then opened and air at 750 psig was applied to hand valve 12. Hand valve 12 was then opened.

4.2.1.3 The piston in the specimen was extended by slowly opening hand valves 2 and 8. Indicator light 'A' was off, and indicator B was on. The pressure at which the pressure switch deactivated was recorded.

4.2.1.4 The piston was retracted by closing valves 2 and 8, and opening valves 3 and 9. Indicator light A was on, and indicator light B was off. The pressure at which the switch activated was recorded.

4.2.1.5 The procedures described in paragraphs 4.2.3 and 4.2.4 were repeated ten times. The unlocking pressure for each cycle was recorded.

4.2.1.6 The piston extended and retracted smoothly with no binding.

4.2.1.7 The system was then bled by closing valve 12 and opening valves 10, 2, and 3, respectively.

4.2.2 LEAKAGE TEST

4.2.2.1 The leakage test was conducted with the specimens installed as shown in figures 4-1 and 4-2.

4.2.2.2 All valves were closed, hand valve 15 and regulator 13 were opened and air at 750 psig was applied to the extend port of the cylinder by opening valves 12 and 8.

4.2.2.3 Valve 5 was then opened and leakage was checked using H_2O container 6 and graduated cylinder 7. The maximum leakage allowed was 5 scim. When graduated cylinder 7 proved to be inadequate, a flowmeter was installed and the test was continued.

4.2.2.4 Valves 5 and 8 were closed and valve 3 was opened. The retract port of the cylinder was then pressurized to 750 psig by opening valve 9, closing valve 3, and opening valve 4. Leakage was checked using H_2O container 6 and graduated cylinder 7. A maximum leakage of 5 scim was allowed. When graduated cylinder 7 proved to be inadequate, a flowmeter was installed and the test was continued.

4.2.2.5 The procedures described in paragraphs 4.2.2.2 through 4.2.2.4 were repeated five times using the flowmeter.

4.2.2.6 The pressure was removed from the test specimens and each specimen was visually examined for structural deformities. All test data were recorded.

4.2.2.7 The procedures described in paragraphs 4.2.2.2 through 4.2.2.4 were repeated, except a 1000-psig pressure was used.

4.2.2.8 The insulation resistance between all nonconnected terminals and between each terminal and the case was determined upon completion of the leakage test.

4.3 TEST RESULTS

4.3.1 During the switch indication test, the piston extended and retracted smoothly with no binding.

4.3.2 For specimen 2 the average leakage past the piston in the unlocked position was 137 scim at 750 psig and 185 scim at 1000 psig. In the locked position the leakage at 750 psig was 128 scim and 180 scim at 1000 psig. Maximum leakage allowed was 5 scim. Specimen 1 operated satisfactorily.

4.3.3 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

4.4 TEST DATA

Test data recorded during the functional test are presented in tables 4-2 and 4-3.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	0002 and 0017	Pneumatic cylinder, double acting
2	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent NC
3	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent NC
4	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
5	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
6	H_2O Container		NA	NA	
7	Graduated Cylinder		NA	NA	0-to 10-scim ±5% FS accuracy
8	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, NC
9	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, NC
10	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent NC
11	Pressure Gage	Heise	NA	H35832	0-to 2000-psig ±0.25% FS accuracy Cal. date 6-23-66
12	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
13	Regulator	Tescom Corp.	26-1003	276	0-to 3000-psig
14	Filter	Bendix	2-8-13480-16-13-0	57	2-micron

Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
15	Hand Valve	Control Components, Inc.	EJ-608-P-P	NA	½-inch
16	GN_2 or Air Source	CCMD	NA	NA	0-to 2000-psig

Table 4-2. Functional Test Data (Specimen 1)

Switch Indication

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	55
2	55	50
3	45	50
4	45	50
5	45	50
6	45	50
7	45	50
8	45	50
9	45	50
10	45	50

Leakage Test

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0.305	0.061
2	750	0.549	0.122
3	750	0.183	0.183
4	750	0.122	0.244
5	750	0.061	0.183
1	1000	0.365	0.061
2	1000	0.549	0.061
3	1000	0.183	0.122
4	1000	0.122	0.122
5	1000	0.061	0.061

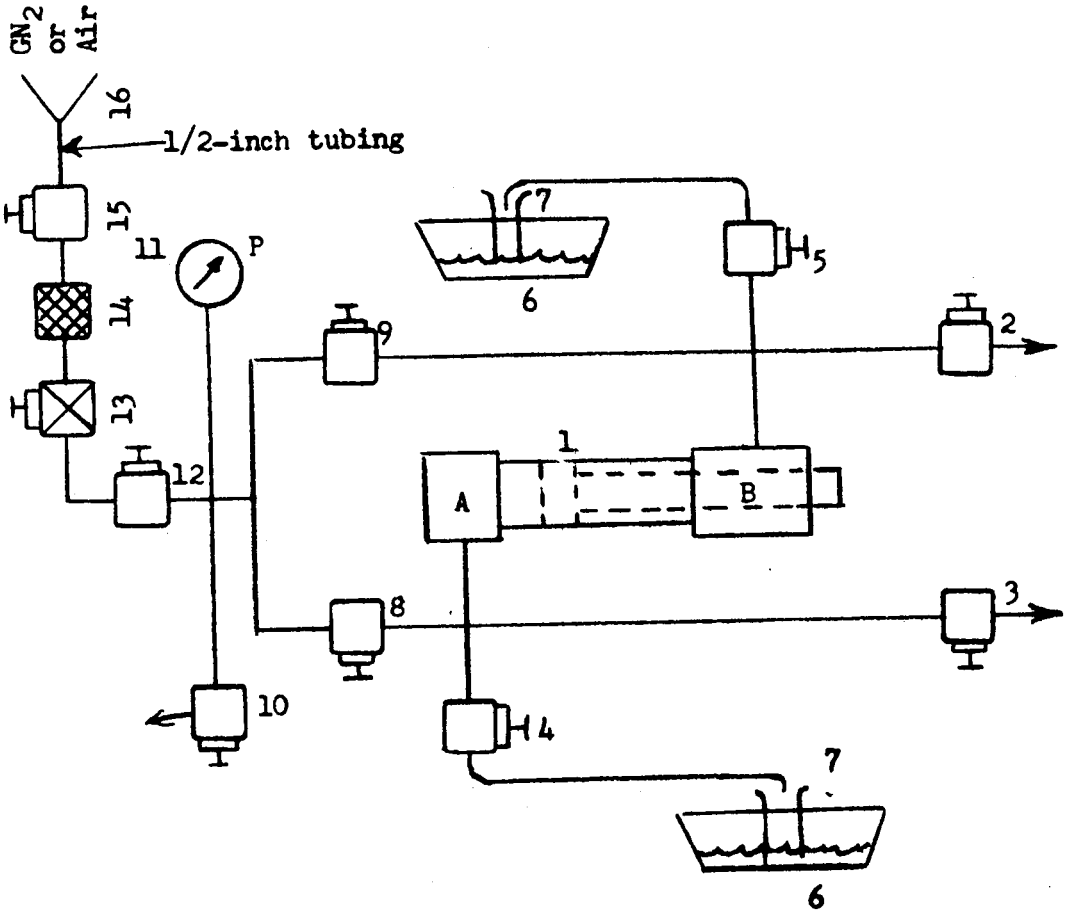
Table 4-3. Functional Test Data (Specimen 2)

Switch Indication

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	60	58
2	60	58
3	60	50
4	55	55
5	55	58
6	55	58
7	58	60
8	60	60
9	60	60
10	60	55

Leakage Test

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	123	112
2	750	123	123
3	750	151	134
4	750	143	134
5	750	143	138
1	1000	187	177
2	1000	182	181
3	1000	187	179
4	1000	181	182
5	1000	185	182



Note: All tubing 1/4 inch unless otherwise noted.
Refer to table 4-1 for item identification

Figure 4-1. Functional Test Schematic

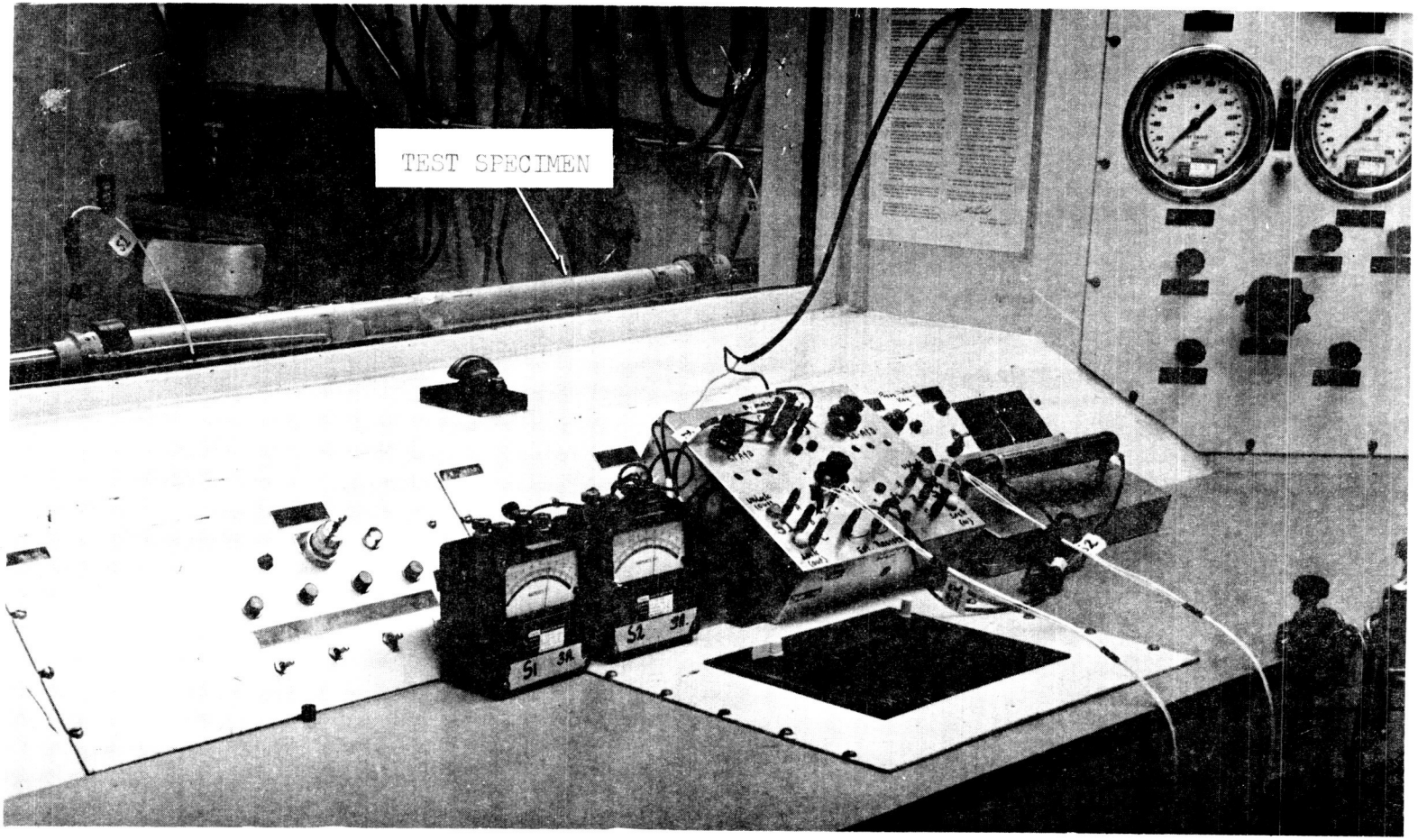


Figure 4-2. Functional Test Setup

SECTION V

LOW TEMPERATURE TEST

5.1 TEST REQUIREMENTS

A functional test shall be performed during the low temperature test using air or GN_2 as test medium. Leakage will be monitored during this test. The rated low temperature shall be 5(+0, -4)°F. Maximum temperature change rate shall be 1°F per minute.

5.2 TEST PROCEDURE

5.2.1 The test specimens were installed as shown in figures 5-1 and 5-2 utilizing the equipment listed in table 5-1.

5.2.2 The chamber was adjusted to stabilize at 5°F with a maximum temperature change rate of 1°F per minute. The relative humidity was between 60 and 90 per cent.

5.2.3 When the specimen temperature stabilized at 5°F, a functional test as specified in section IV was performed.

5.2.4 Upon completion of the functional test, the chamber was returned to room ambient conditions. Within 1 hour following the return of the test specimen to room ambient conditions, a visual inspection and a functional test as specified in section IV were performed. All test data were recorded.

5.3 TEST RESULTS

5.3.1 The rated low temperature of 5°F was established during the test, with a maximum temperature change rate of 1°F per minute.

5.3.2 The specimens withstood the low temperature test, except for leakage past the piston in both specimens.

5.3.3 During the low temperature test on specimen 1, leakage past the piston in the unlocked position at 750 psig averaged 111 scim, and at 1000 psig averaged 115 scim. Leakage in the locked position at 750 psig averaged 4.5 scim, and at 1000 psig averaged 3.5 scim. On specimen 2, leakage past the piston in the unlocked position at 750 psig averaged 1090 scim, and at 1000 psig averaged 1290 scim. Leakage in the locked position at 750 psig averaged 1310 scim, and at 1000 psig averaged 1460 scim.

5.3.4 After specimen 1 was returned to ambient conditions, the leakage past the piston was under 5 scim.

After specimen 2 was returned to ambient conditions, the leakage past the piston in the unlocked position at 750 psig averaged 82.5 scim, and at 1000 psig averaged 102.5 scim. Leakage in

the locked position at 750 psig averaged 90 scim, and at 1000 psig averaged 112.5 scim.

5.3.5 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

5.3.6 Test specimen 2 (SN 0002) was subjected to a low temperature retest. The specimen had been disassembled and reassembled with new piston seals prior to the retest. Results of the test were considered satisfactory.

5.4 TEST DATA

5.4.1 Functional test data recorded during the low temperature test are presented in table 5-2.

5.4.2 Functional test data recorded after the low temperature test are presented in table 5-3.

Table 5-1. Low and High Temperature Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	0002 and 0017	Pneumatic cylinder, double acting
2	Test Chamber	Conrad	NA	NA	Low temperature and humidity
3	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent
4	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent
5	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
6	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
7	Flowmeter	Fisher and Porter	630643703 -A12	NA	0-to 10-scim ±5% FS accuracy
8	Flowmeter	Fisher and Porter	630643703 -A12	NA	0-to 10-scim ±5% FS accuracy
9	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
10	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
11	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch, vent
12	Pressure Gage	Ashcroft	1850	NA	0-to 2000-psig ±0.25% FS accuracy Cal. date 10-10-67
13	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
14	Regulator	Grove	NA	L 45106	0-to 3000-psig

Table 5-1. Low and High Temperature Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
15	Hand Valve	Combination Valve and Pump Co.	PL 673	NA	½-inch
16	Filter	Bendix	NA	1731261	2-micron
17	GN_2 or Air Source	CCMD	NA	NA	0-to 2000-psig
18	Test Chamber	Conrad	NA	NA	High temperature and humidity

Table 5-3. Post-Low Temperature Test
Functional Test Data (Ambient Conditions)

Switch Indication (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)	
1	55	50	
2	55	50	
3	55	50	

Leakage Test (Specimen 1)

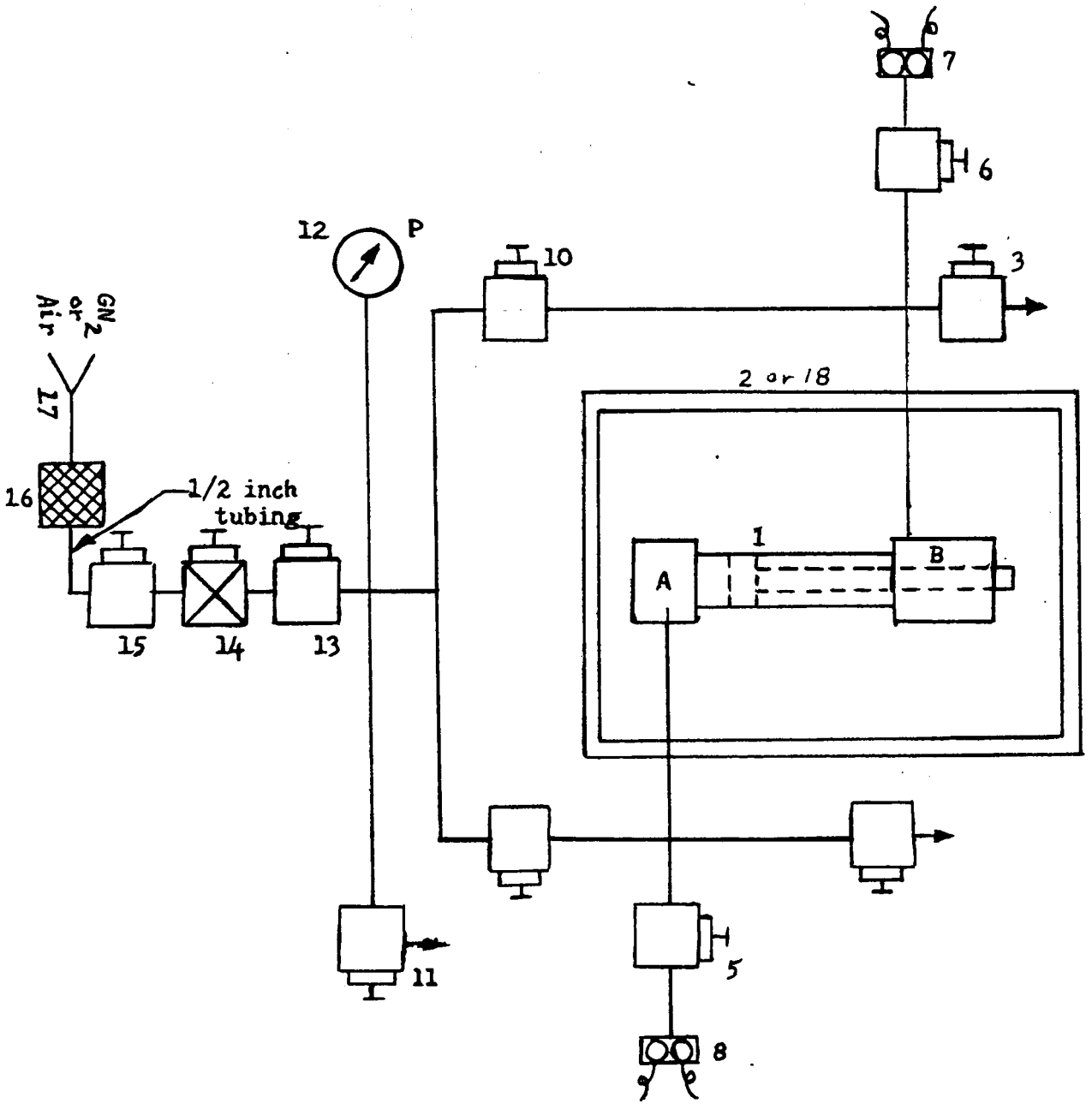
Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	1.28	0
2	750	1.72	0.305
1	1000	1.40	0
2	1000	1.22	0.183

Switch Indication (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)	
1	55	52	
2	53	52	
3	55	52	

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	85	75
2	750	80	105
1	1000	105	95
2	1000	100	130



Note: All tubing $\frac{1}{4}$ inch unless otherwise noted.
Refer to table 5-1 for item identification.

Figure 5-1. Low and High Temperature Test Schematic

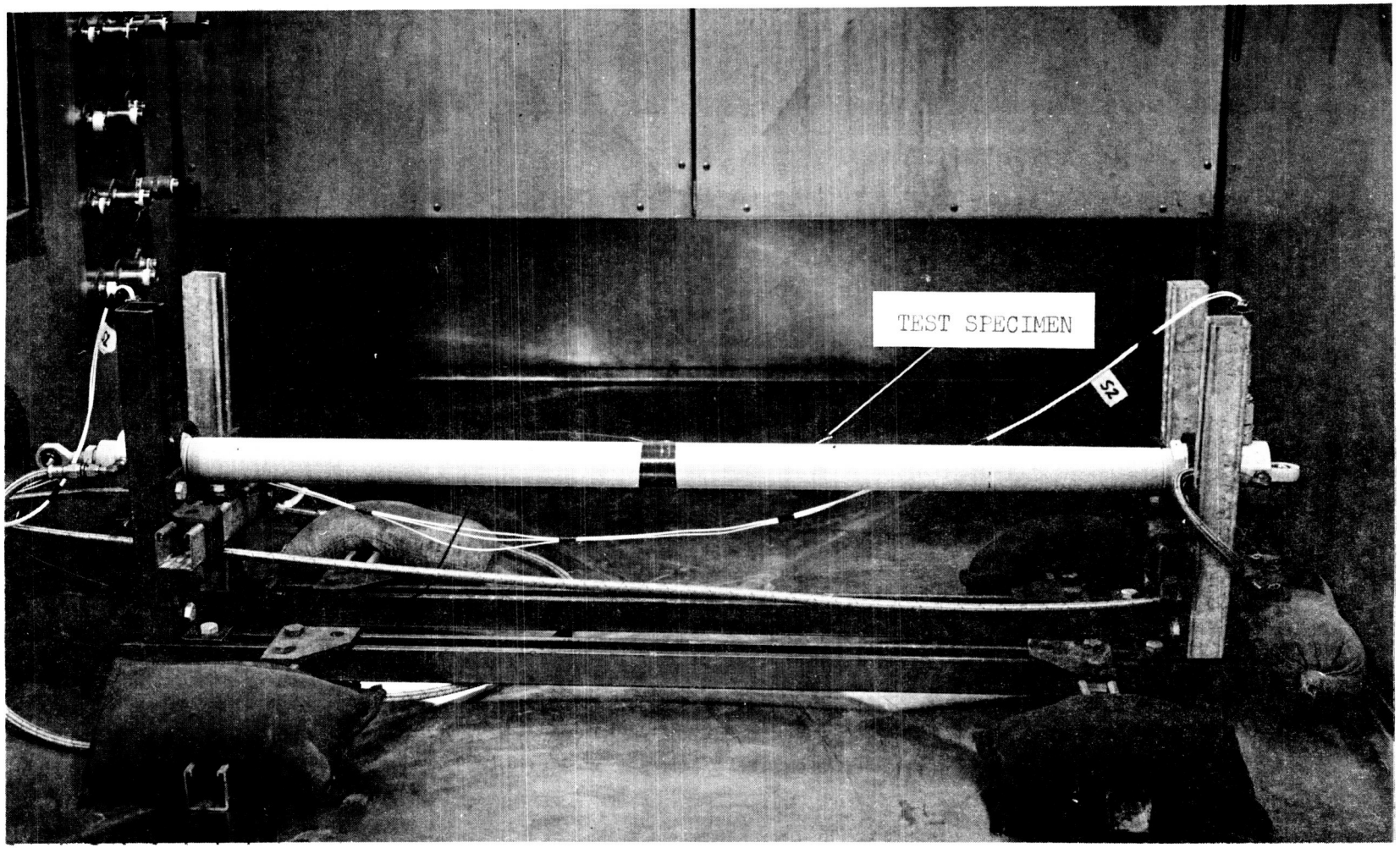


Figure 5-2. Low and High Temperature Test Setup

SECTION VI

HIGH TEMPERATURE TEST

6.1 TEST REQUIREMENTS

A functional test shall be performed during the high temperature test using air or GN_2 as test medium. Leakage will be monitored during this test. The rated high temperature shall be 160(+4,-0)°F.

6.2 TEST PROCEDURE

6.2.1 The test specimens were installed as shown in figures 5-1 and 5-2 utilizing the equipment listed in table 5-1.

6.2.2 The chamber was adjusted to stabilize at 160°F for 72 hours with a maximum temperature change rate of 1°F per minute. The relative humidity was 20 per cent.

6.2.3 With the specimen temperature stabilized at 160°F, a functional test as specified in section IV was performed.

6.2.4 Upon completion of the functional test, the chamber was returned to room ambient conditions. Within 1 hour following the return of the test specimen to room ambient conditions, a visual inspection and a functional test as specified in section IV were performed. All test data were recorded.

6.3 TEST RESULTS

6.3.1 The rated high temperature of 160°F was maintained for a 72-hour period, with a maximum temperature change rate of 1°F per minute. The relative humidity was 20 per cent.

6.3.2 The specimens withstood the high temperature environment, except for leakage in specimen 2.

6.3.3 During the high temperature test on specimen 2, leakage past the piston in the unlocked position at 750 psig averaged 7 scim, and at 1000 psig averaged 9 scim. Leakage past the piston in the locked position at 750 psig averaged 7.5 scim, and at 1000 psig averaged 8 scim.

6.3.4 After specimen 2 was returned to ambient conditions, leakage past the piston in the unlocked position at 750 psig averaged 150 scim, and at 1000 psig averaged 172.5 scim. Leakage past the piston in the locked position at 750 psig averaged 145 scim, and at 1000 psig averaged 180 scim.

6.3.5 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

6.4 TEST DATA

6.4.1 Functional test data recorded during the high temperature test are presented in table 6-1.

6.4.2 Functional test data recorded after the high temperature test are presented in table 6-2.

Table 6-1. High Temperature Test
Functional Test Data Obtained at 160°F

Switch Indication (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	50	50
2	50	50
3	50	50

Leakage Test (Specimen 1)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0.488	0.122
2	750	0.549	0.488
1	1000	0.183	0.122
2	1000	0.305	0.305

Switch Indication (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	52
2	55	52
3	55	52

Leakage Test (Specimen 2, Serial No. 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	7	8
2	750	7	7
1	1000	10	8
2	1000	8	8

Table 6-2. Post-High Temperature Test
Functional Test Data (Ambient Conditions)

Switch Indication (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	50
2	55	50
3	55	50

Leakage Test (Specimen 1)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	1.28	0
2	750	1.22	0.305
1	1000	1.40	0
2	1000	1.22	0.183

Switch Indication (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	52
2	55	52
3	55	55

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	145	155
2	750	155	135
1	1000	170	185
2	1000	175	175

SECTION VII

SURGE TEST

7.1 TEST REQUIREMENTS

7.1.1 The extend and retract ports shall be alternately pressurized from zero to 750 psig with air or GN_2 as the pressure medium.

7.1.2 Each test specimen shall be subjected to 1000 pressure surges (500 extended and 500 retracted) with the pressure rise time being within 100 milliseconds.

7.1.3 The cylinders shall be loaded with a 20-pound load during the test and vented through a 0.125-inch-diameter orifice.

7.2 TEST PROCEDURE

7.2.1 The surge test setup was assembled as shown in figures 7-1 and 7-2 utilizing the equipment listed in table 7-1.

7.2.2 It was determined that all connections were tight, all gages were installed and operating properly, and all valves were closed.

7.2.3 With the cylinder loaded with a 20-pound load (3), the extend port of the cylinder was pressurized from zero to 750 psig within 100 milliseconds by opening valve 12, regulator 11, and valves 9 and 6. With the cylinder piston extended, valve 6 was closed and the pressure vented through orifice 18.

7.2.4 The retract port of the cylinder was then pressurized from zero to 750 psig within 100 milliseconds by opening valve 7. With the cylinder piston retracted, valve 7 was closed and the pressure vented through orifice 17.

7.2.5 The extend and retract ports of the cylinder were alternately pressurized as described in paragraphs 7.2.3 and 7.2.4 for 1000 pressure surges (500 extended and 500 retracted).

7.2.6 At the completion of 1000 pressure surges, the pressure was removed from the cylinder ports by closing valves 6, 7, 9, 11, and 12.

7.2.7 Upon completion of the pressure surge test, a visual examination and a functional test as specified in section IV were performed. All test data were recorded.

7.3 TEST RESULTS

7.3.1 A zero-to 750-psig pressure surge was accomplished in 30 milliseconds, which was within the specified maximum of 100 milliseconds.

7.3.2 The specimens withstood 1000 surge cycles.

7.3.3 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

7.3.4 Prior to the functional test on specimen 2, new piston seals were installed in the pneumatic cylinder per factory instructions.

7.4 TEST DATA

7.4.1 A typical surge waveform as recorded during the test is presented in figure 7-3.

7.4.2 Functional test data recorded after the surge test are presented in table 7-2.

Table 7-1. Surge Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	2 and 0017	Pneumatic cylinder, double acting
2	Pully	CCMD	NA	NA	
3	Weight		NA	NA	20-pound
4	Transducer	CEC	4-350-0001	2720	0-to 3000-psig ±0.4% FS accuracy
5	Transducer	CEC	4-350-0001	1756	0-to 3000-psig ±0.4% FS accuracy
6	Solenoid Valve	Marotta	MV 74	17204	½-inch, 3-way
7	Solenoid Valve	Marotta	MV 74	823	½-inch, 3-way
8	Surge Tank	Bendix	NA	NA	3000-psig max. working pressure, air or GN_2
9	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
10	Pressure Gage	Heise	NA	H40172	0-to 3000-psig ±0.25% FS accuracy Cal. date 10-13-66
11	Regulator	Tescom Corp.	NA	1526	0-to 3000-psig
12	Hand Valve	Combination Pump and Valve Co.	PL 673	NA	½-inch
13	Recorder	CEC	NA	5-124	
14	Timer	Cramer Control	540	Y3336A	
15	Filter	Bendix	5-S-13460 -16-13-0	24	2-micron

Table 7-1. Surge Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
16	GN_2 or Air Source	CCMD	NA	NA	0-to 3500-psig
17	Orifice		AN	NA	0.125-inch-diam.
18	Orifice		AN	NA	0.125-inch-diam.

Table 7-2. Post-Surge Test Functional Test Data

Switch Indication (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	50
2	55	50
3	55	50

Leakage Test (Specimen 1)

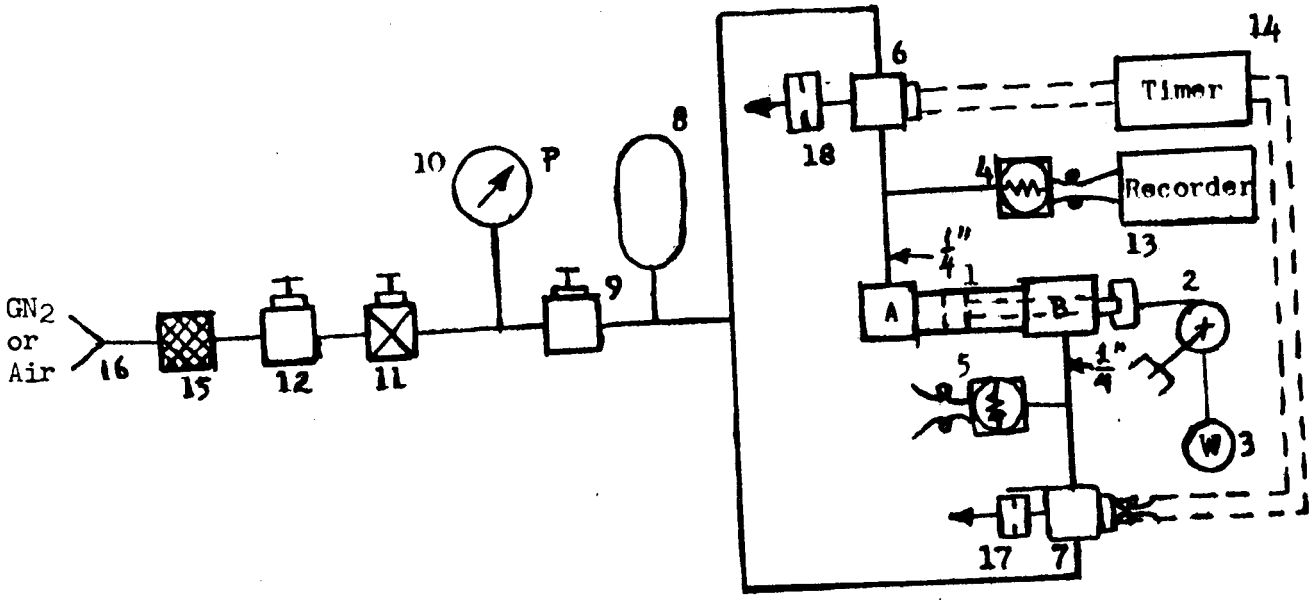
Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0
2	750	0	0
1	1000	0	0
2	1000	0	0

Switch Indication (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	50
2	55	50
3	55	50

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0
2	750	0	0
1	1000	0	0
2	1000	0	0



Note: All tubing 1/2 inch unless otherwise noted.
Refer to table 7-1 for item identification.

Figure 7-1. Surge Test Schematic

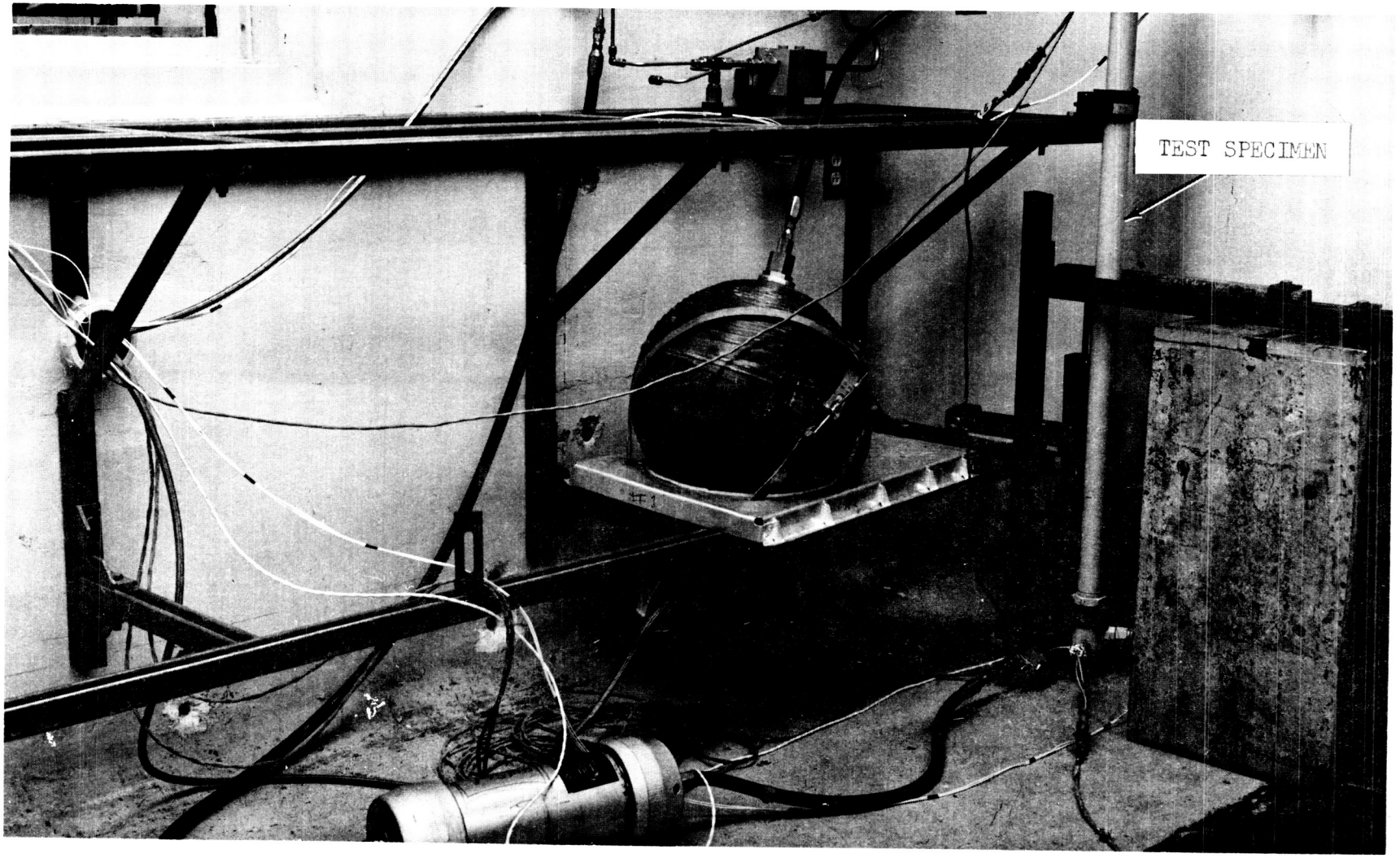


Figure 7-2. Surge Test Setup

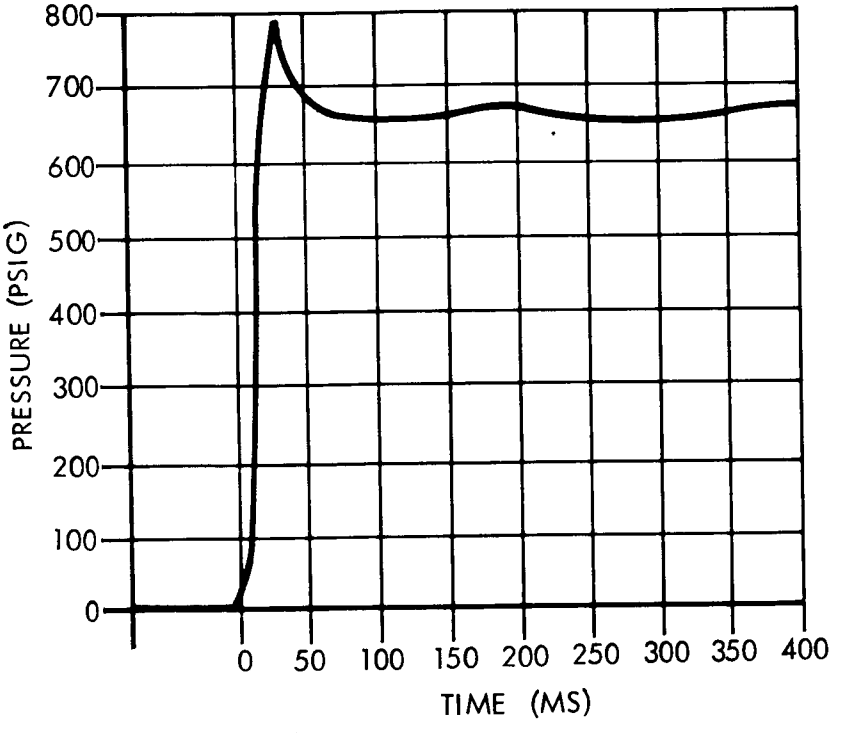


Figure 7-3. Typical Surge Waveform

SECTION VIII

VIBRATION TEST

8.1 TEST REQUIREMENTS

8.1.1 Vibration tests shall be performed on test specimens 1 and 2 to determine whether the environment causes degradation or deformation. The tests shall be performed in accordance with KSC-STD-164(D), Procedure I, Section 9, Figures 9.1 and 9.2, at vibration level C. The retract port of the cylinder shall be pressurized to 750 psig and indicator switches monitored during the vibration test.

8.1.2 RESONANT FREQUENCY SEARCH

The fixture/test specimen assembly shall be exposed to sinusoidal vibration at the input levels shown in table 8-1. A frequency range of 5 to 2000 cps shall be traversed logarithmically in directions of both increasing and decreasing frequency over a time period not to exceed 15 minutes per axis. Actual test time shall be noted. All fixture and test specimen resonant frequencies and the structural member in resonance shall be noted. In addition, critical frequencies of the test specimen shall be noted. Critical frequencies are those frequencies at which functional degradation occurs.

Table 8-1. Resonant Frequency Search Levels

Frequency (cps)	Displacement (D. A. Inch)	Acceleration (g)
5 to 65	0.01	--
65 to 2000	--	2.0

8.1.3 SINUSOIDAL SWEEP

In one 20-minute sweep the frequency range shall be scanned logarithmically from 10 to 2000 cps and back to 10 cps. Critical frequencies of the test specimen shall be noted. The test specimen shall be functionally tested as specified in section IV after the sinusoidal sweep test has been completed. The sinusoidal sweep input levels shall be as shown in table 8-2.

Table 8-2. Sinusoidal Sweep Vibration Levels

Frequency (cps)	Displacement (D. A. Inch)	Acceleration (g)
10 to 65	0.1	--
65 to 2000	--	20

8.1.4 RANDOM EXCITATION

The test specimen shall be exposed to random vibration at the specified levels over a frequency range from 10 to 2000 cps for 5 minutes. The specified random input levels shall be as shown in table 8-3.

Table 8-3. Random Excitation Vibration Levels

Frequency (cps)	Slope (db /octave)	PSD (g^2/cps)
10 to 100	+ 6	--
100 to 1000	--	0.05
1000 to 2000	- 6	--

8.1.5 Acceleration shall be measured at the test assembly by accelerometers mounted on the assembly.

8.1.6 The vibration test shall be conducted in three mutually perpendicular axes. The previously described testing is for one axis and shall be completed before proceeding to the next axis.

8.1.7 Fixture design shall be as specified in KSC-STD-164(D).

8.1.8 Test tolerances shall be as follows: Sinusoidal amplitude ± 2 per cent, acceleration density ± 3 db, broad band grms $\pm 1\frac{1}{2}$ per cent or ± 2 cycles (whichever is greater), and time ± 1 per cent.

8.2 TEST PROCEDURE

8.2.1 RESONANT FREQUENCY SEARCH

8.2.1.1 The vibration test setup was assembled as shown in figures 8-1 through 8-3 utilizing the equipment listed in table 8-4.

8.2.1.2 It was determined that all connections were tight, all gages were installed and operating properly, and all valves were closed.

8.2.1.3 The retract port of the cylinder was pressurized to 750 psig with air by opening valves 6, 5, and 4. The indicator switches were monitored during the test.

8.2.1.4 The frequency was scanned logarithmically from 5 to 2000 cps and back to 5 cps over a time period of 14 minutes. Input levels are presented in table 8-1.

8.2.1.5 All test data and actual survey time were recorded.

8.2.2 SINUSOIDAL SWEEP TEST

8.2.2.1 The frequency was scanned logarithmically from 10 to 2000 cps and back to 10 cps over a time period of 20 minutes. Input levels are presented in table 8-2.

8.2.2.2 All test data and actual scan time were recorded. Upon completion of the sinusoidal scan, a functional test as specified in section IV was performed.

8.2.3 RANDOM EXCITATION TEST

8.2.3.1 The test assembly was subjected to random excitation ranging from 10 to 2000 cps for 5 minutes. The specified random input levels are shown in table 8-3.

8.2.3.2 All test data and actual random time were recorded. Upon completion of the random excitation test, a functional test as specified in section IV was performed.

8.2.3.3 Procedures described in paragraphs 8.2.1.1 through 8.2.3.2 were performed for each of the remaining two mutually perpendicular axes.

8.3 TEST RESULTS

8.3.1 Both specimens withstood vibration testing in the three mutually perpendicular axes.

8.3.2 During the sinusoidal scan in the first axis of vibration (X-axis) for specimen 2, the extend pressure switch light failed to operate. Testing was continued until completion of vibration testing.

8.3.3 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

8.4 TEST DATA

8.4.1 A vibration test summary is presented in table 8-5 and typical control accelerometer plots as recorded during the test are presented in figures 8-4 through 8-6.

8.4.2 Functional test data recorded after the vibration test are presented in table 8-6.

Table 8-4. Vibration Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	2 and 0017	Pneumatic cylinder, double acting
2	Vibration Exciter	MB	210	NA	
3	Pressure Gage	Ashcroft	1850	NA	0-to 1000-psig ±0.25% accuracy Cal. date 10-12-66
4	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
5	Regulator	Grove	NA	L 45107	0-to 3000-psig ±0.25% accuracy
6	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
7	Filter	Bendix	NA	1731261	2-micron
8	Air or GN_2 Source	CCMD	NA	NA	0-to 1000-psig
9	Accelerometer (Control)	Endevco Corp.	NA	Hc77	0 to 500g
10	Accelerometer (Response)	Endevco Corp.	NA	LJ35 MB44 JD61	0 to 500g

Table 8-6. Post-Vibration Functional Test Data

Unlocking and Locking Pressure (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	140	50
2	50	50
3	50	50

Leakage Test (Specimen 1)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0.854	0.061
2	1000	0.915	0

Unlocking and Locking Pressure (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	55	50
2	50	50
3	50	50

Leakage Test (Specimen 2)

Run	Pressure (psig)	Pressure, Piston Unlocked (scim)	Pressure, Piston Locked (scim)
1	750	0	0.061
2	1000	0	0.061

Table 8-5. Vibration Test Summary (Specimens 1 and 2)

	Resonant Frequency				Sinusoidal Vibration				Random Vibration			
Axis	Required Level	Time (Min.)	Actual Level	Time (Min.)	Required Level	Time (Min.)	Actual Level	Time (Min.)	Required Level	Time (Min.)	Actual Level	Time (Min.)
X	5 to 65 cps at 0.01-inch DA displacement. 65 to 2000 cps at 2.0G	14.00	Same as required level	14.00	10 to 65 cps at 0.1-inch DA displacement. 65 to 2000 cps at 20.0G	20.00	Same as required level	20.00	10 to 100 cps at +6 db/ octave. 100 to 1000 cps at 0.05 G^2/cps 1000 to 2000 cps at -6 db/Octave	5.00	Same as required level	5.00
Y	Same as above	14.00		14.00	Same as above	20.00		20.00	Same as above	5.00		5.00
Z	Same as above	14.00		14.00	Same as above	20.00		20.00	Same as above	5.00		5.00
TOTAL TIME		42.00		42.00		60.00		60.00		15.00		15.00

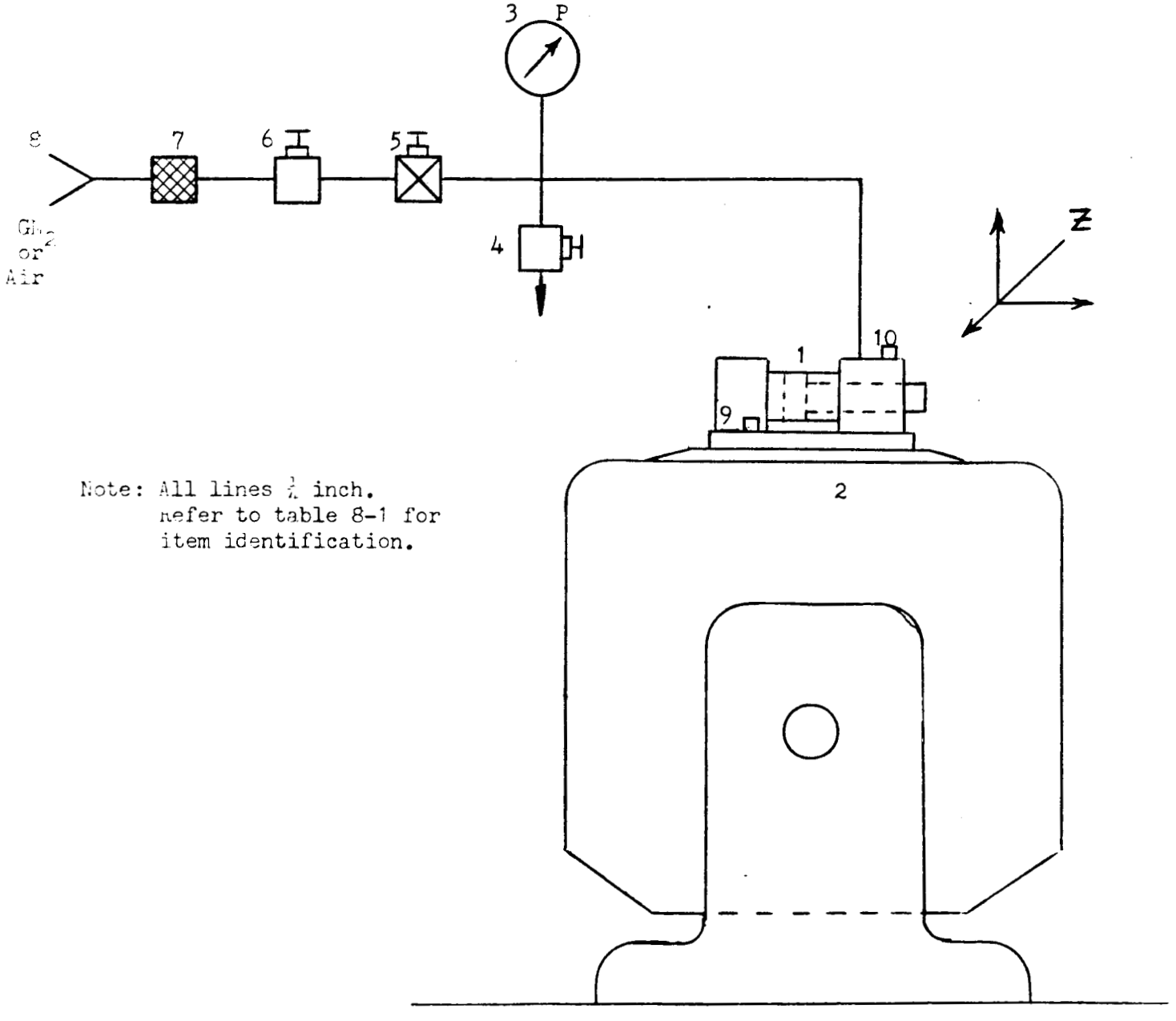


Figure 8-1. Vibration Test Schematic

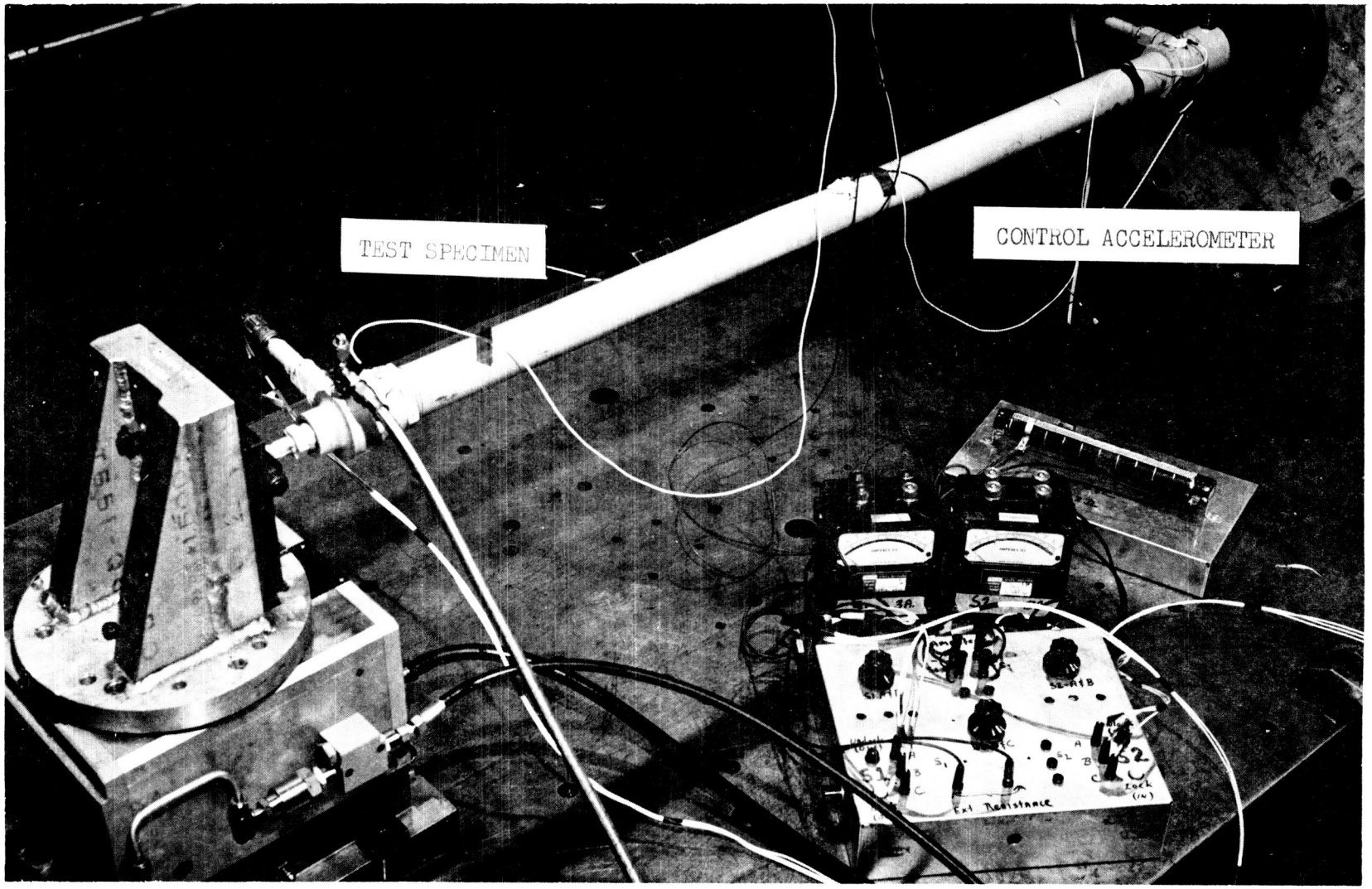


Figure 8-2. Vibration Test Setup - Z-Axis

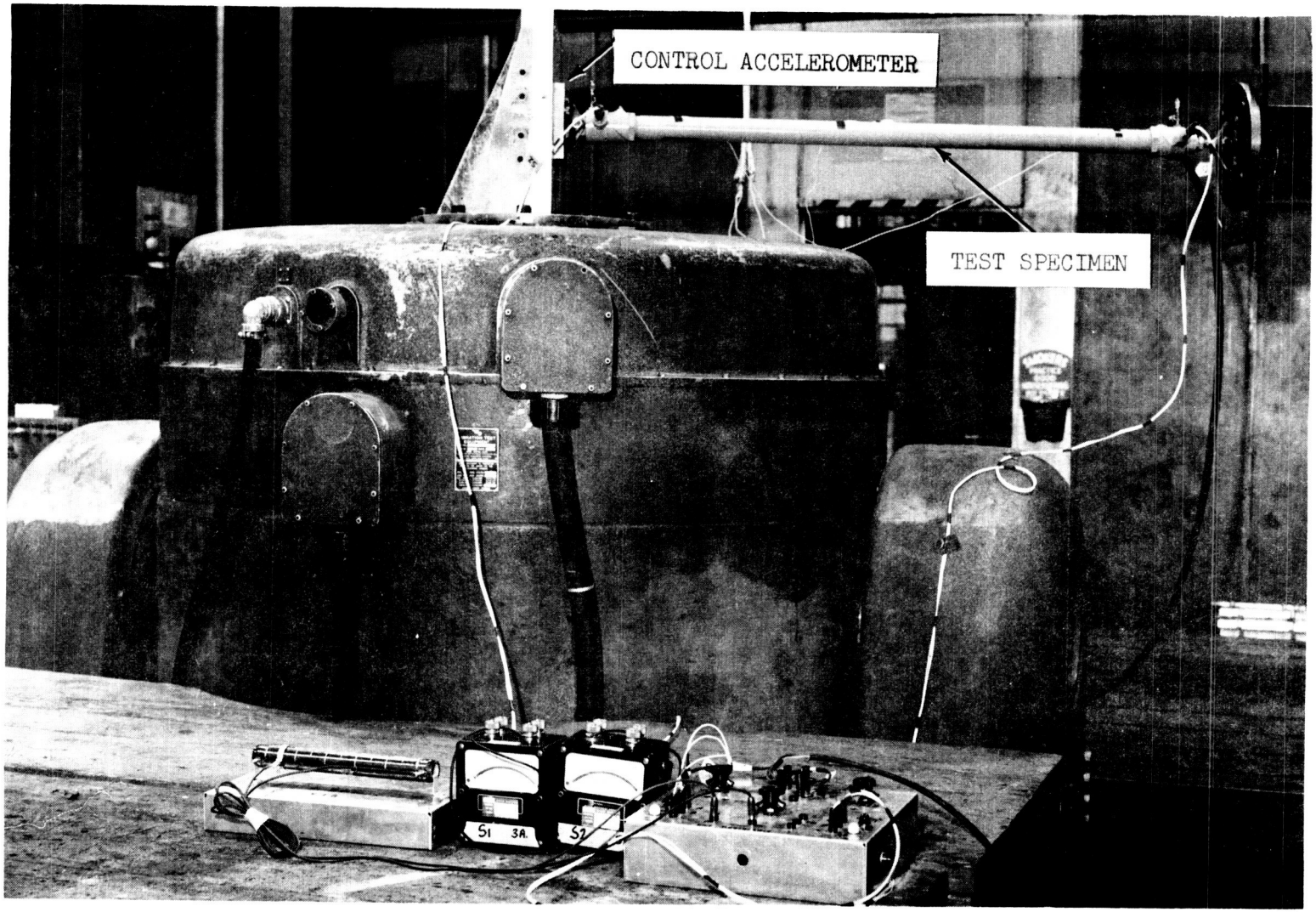


Figure 8-3. Vibration Test Setup - X and Y Axes

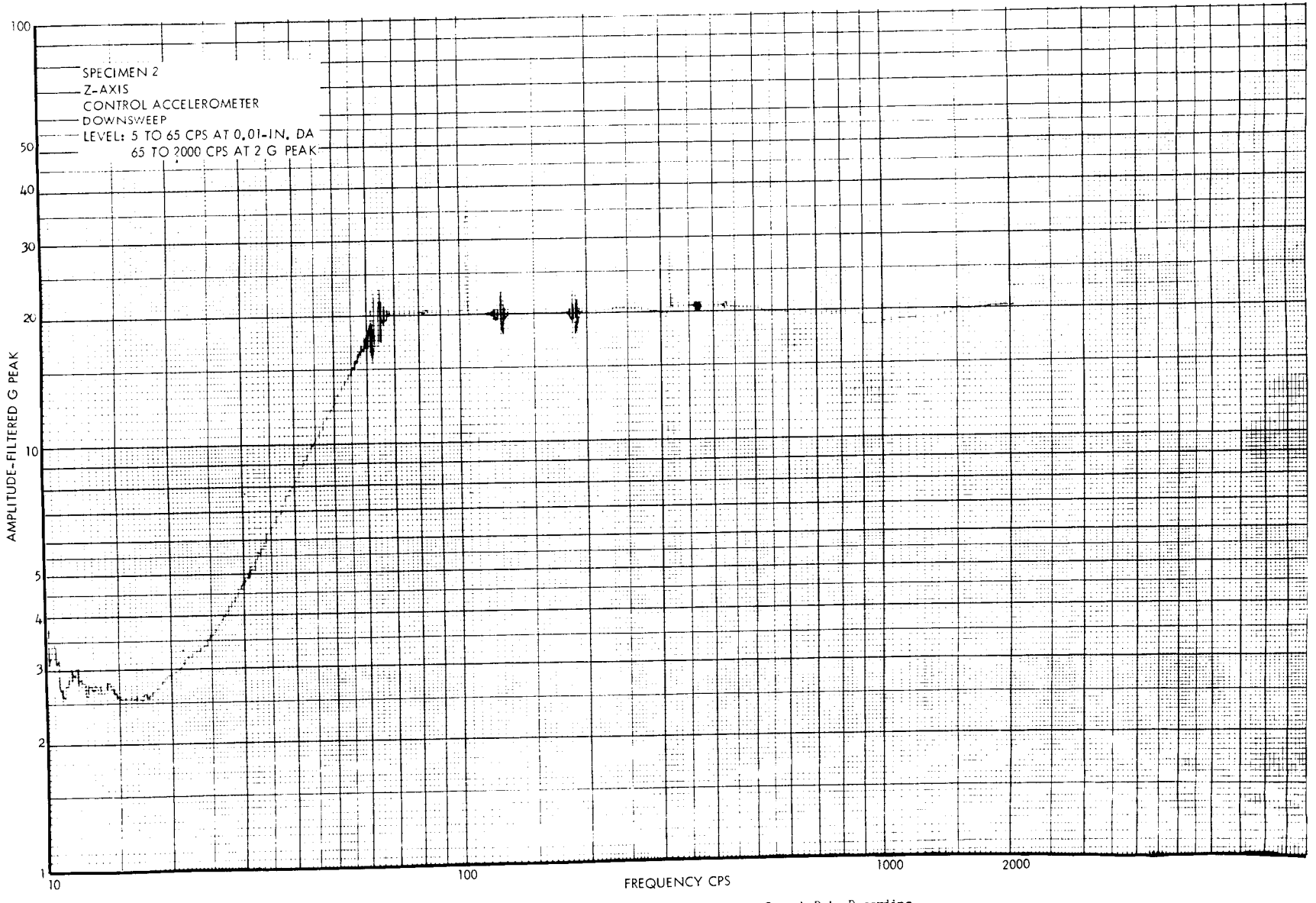


Figure 8-4. Typical Resonant Frequency Search Data Recording

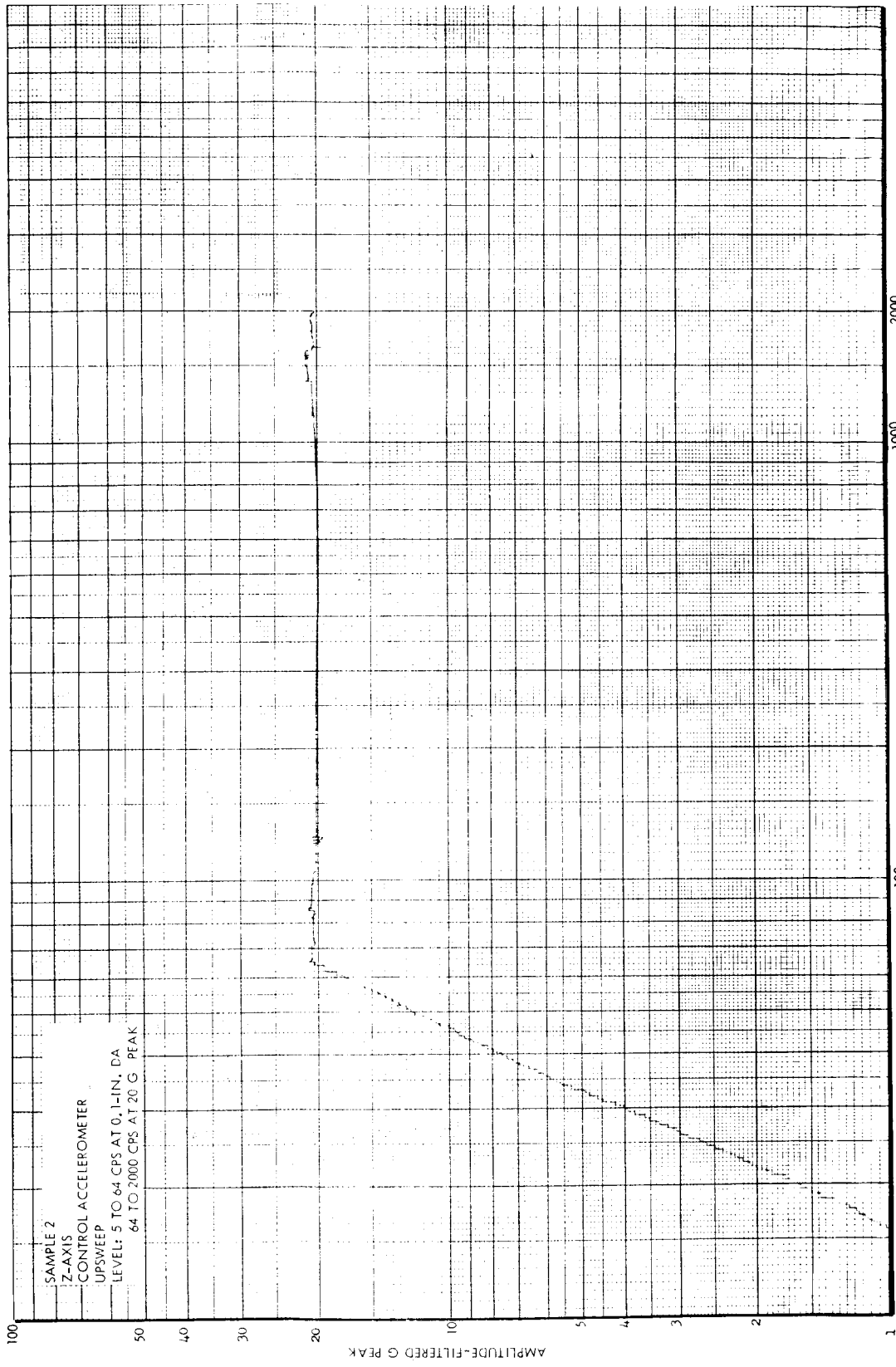


Figure 8-5. Typical Sensusoidal Vibration Data Recording

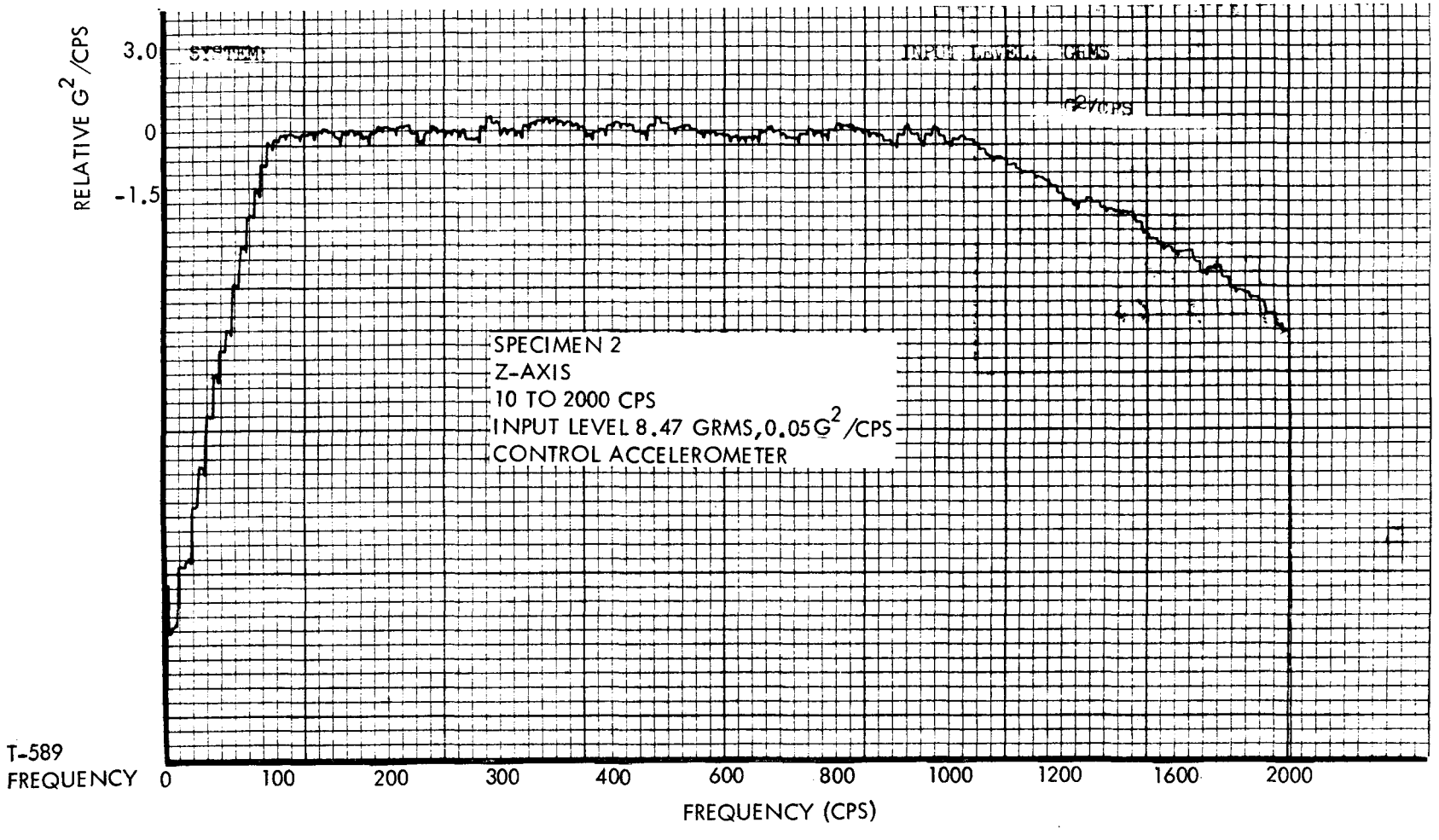


Figure 8-6. Typical Random Vibration Data Recording

SECTION IX

SAND AND DUST TEST

9.1 TEST REQUIREMENTS

9.1.1 A sand and dust test shall be performed on specimen 1. The test specimen shall be subjected to 2 hours of exposure to fine sand and dust with a velocity of 100 to 500 feet per minute and a temperature of 77°F.

9.1.2 At the end of the 2-hour period, the temperature shall be increased to 160°F. This temperature shall be maintained for an additional 2 hours.

9.1.3 Following the preceding exposure time, the test specimen shall be removed from the test chamber and allowed to cool to room temperature.

9.2 TEST PROCEDURE

9.2.1 With ports capped, the test specimen was placed in the sand and dust chamber (see table 9-1) as specified in KSC-STD-164(D). The chamber contained sand and dust with the characteristics as prescribed in KSC-STD-164(D). The density of the sand and dust was maintained at 0.1 to 0.25 grams per cubic feet

9.2.2 The internal temperature of the test chamber was set at 77°F. This condition was maintained for 2 hours with air velocity of 100 to 500 feet per minute through the test chamber.

9.2.3 At the end of the 2-hour period, the temperature was raised to 160°F and the specimen was tested for 2 hours at this condition. At the end of this exposure period, the test specimen was removed from the chamber and allowed to cool to room temperature.

9.2.4 The accumulated dust from the test was removed from the specimen by brushing, wiping, and shaking. The specimen was inspected for sand and dust deposits to ensure that additional dust had not been introduced into the specimen.

9.2.5 Upon completion of the sand and dust test, a functional test as specified in Section IV was performed. All test data were recorded.

9.3 TEST RESULTS

9.3.1 The rated internal temperature of the test chamber was maintained for 2 hours at 77°F and 2 hours at 160°F with the air velocity through the test chamber at 100 to 500 feet per minute.

9.3.2 The specimen withstood the sand and dust environment.

9.3.3 During the functional test, the switch on the extend side of the cylinder failed to operate. Upon completion of the functional test, the switch was disassembled and inspected for fatigue failure. There was no indication of fatigue failure inside the switch; however, sand and dust particles (as shown in figure 9-1) were found inside the The cause of failure was attributed to a sticky plunger located inside the pressure switch assembly which was damaged by sand and dust penetration.

9.3.4 The switch was cleaned and installed on the cylinder. A functional test was then performed to check the operation of the pressure switch. The switch operated normally during the functional test.

9.3.5 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

9.4 TEST DATA

Functional test data recorded after the sand and dust test are presented in table 9-2.

Table 9-1. Sand and Dust Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	0017	Pneumatic cylinder, double acting
2	Test Chamber, Sand and Dust		NA	NA	

Table 9-2. Post-Sand and Dust Test Functional Test Data

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	25	25
2	25	25
3	25	25

Leakage Test

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0.366
2	1000	0	0.427

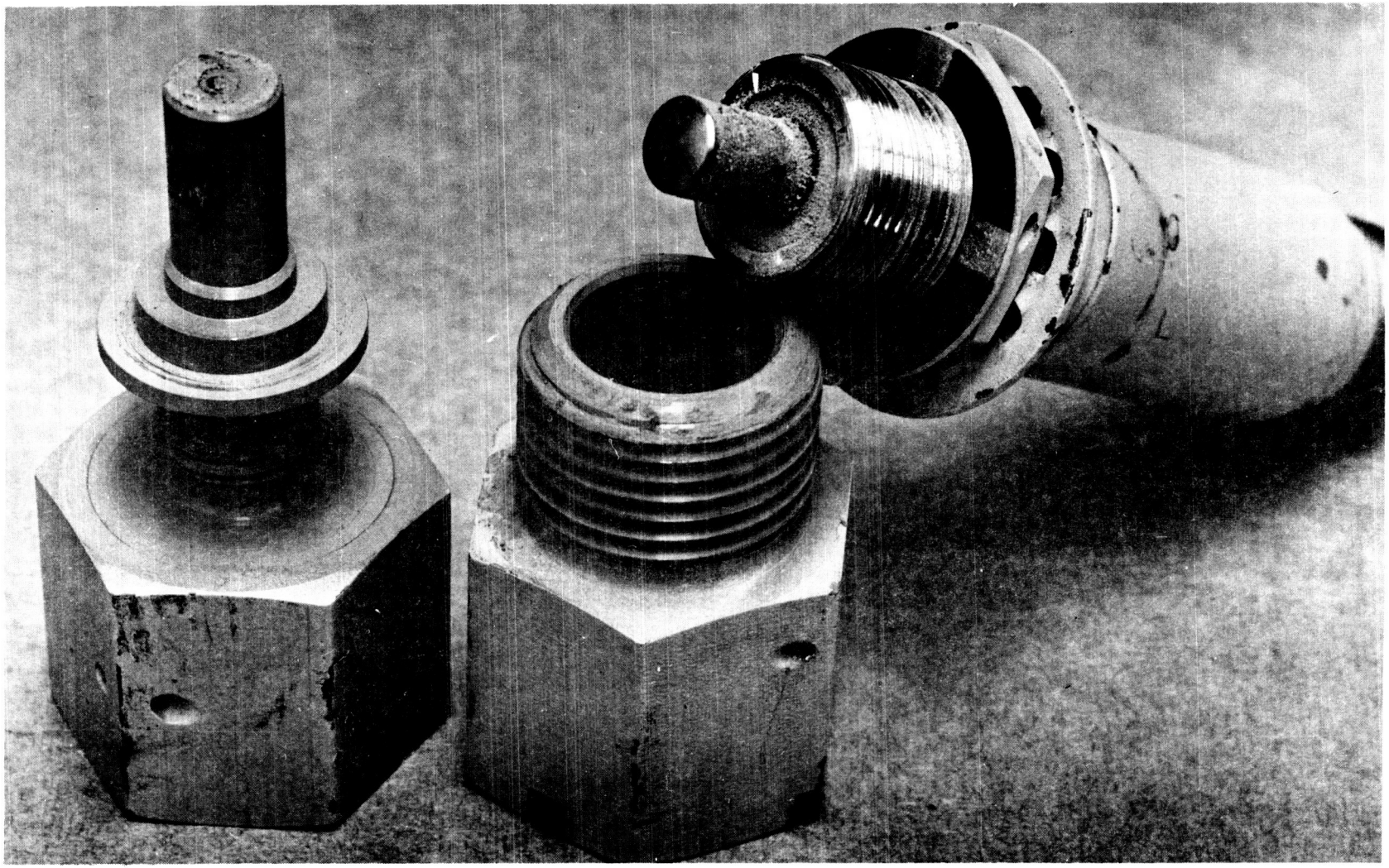


Figure 9-1. Location of Sand and Dust Particles

SECTION X

CYCLE TEST

10.1 TEST REQUIREMENTS

10.1.1 The test specimens shall be subjected to 5000 pressure cycles with a 20-pound load applied. Each cycle shall consist of slowly extending and then retracting the cylinder. The unlock switches shall have a 3-ampere resistive load at 28 vdc.

10.1.2 A functional test shall be performed after 100, 500, 1000, and 5000 cycles.

10.2 TEST PROCEDURE

10.2.1 The cycle test setup was assembled as shown in figures 10-1 and 10-2 utilizing the equipment listed in table 10-1.

10.2.2 It was determined that all connections were tight, all gages were installed and operating properly, and all valves were closed.

10.2.3 With weight 2 (20-pound load) applied, the cylinder was slowly extended and then retracted using 750-psig air pressure. This constituted one cycle. Each specimen was subjected to 5000 cycles. The unlock switches had a 3-ampere resistive load at 28 vdc.

10.2.4 The specimens were visually inspected and functionally tested after 100, 500, 1000, and 5000 cycles. All test data were recorded.

10.3 TEST RESULTS

10.3.1 Each specimen was subjected to 5000 cycles.

10.3.2 Upon completion of 3044 pressure cycles, the switch (retract position) on specimen 2 failed to operate. Testing was continued until completion of 5000 cycles. Upon completion of the test, both switch assemblies were disassembled, cleaned, and adjusted. The switches were then installed on the cylinder and tested for operation. Both switches operated normally.

10.3.3 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

10.3.4 The specimens withstood the cycle test.

10.4 TEST DATA

Functional test data recorded after 100, 500, 1000, and 5000 pressure cycles are presented in tables 10-2 through 10-5.

Table 10-1. Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	2 and 0017	Pneumatic cylinder, double acting
2	Weight	CCMD	NA	NA	20-pound
3	Counter	Durant	5-YE-8949	665	
4	Timer	Cramer Control	540	Y3336A	
5	Power Supply		NA	NA	28-vdc
6	Switch		NA	NA	
7	Solenoid Valve	Marotta	MV74	17204	$\frac{1}{4}$-inch, 3-way NO
8	Solenoid Valve	Marotta	MV74	823	$\frac{1}{4}$-inch, 3-way NC
9	Hand Valve	Robbins Aviation	SSK 250-4T	NA	$\frac{1}{4}$-inch
10	Pressure Gage	Heise	NA	H41072	0-to 3000-psig $\pm$0.25% accuracy Cal. date 10-13-66
11	Regulator	Tescom Corp.	NA	1526	0-to 3000-psi
12	Hand Valve	Combination Pump and Valve Co.	PL673	NA	$\frac{1}{2}$-inch
13	Filter	Bendix	5-S-13460-16-B-10	24	2-micron
14	Air or GN_2 Source	CCMD	NA	NA	0-to 3500-psig
15	Pulley	CCMD	NA	NA	

Table 10-2. Functional Test Data Obtained at 100 Cycles

Unlocking and Locking Pressure (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	30	30
2	30	30
3	30	30

Leakage Test (Specimen 1)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0.549	0
2	1000	0.488	0

Unlocking and Locking Pressure (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	50	50
2	50	50
3	50	50

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0
2	1000	0	0

Table 10-3. Functional Test Data Obtained at 500 Cycles

Unlocking and Locking Pressure (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	30	30
2	30	30
3	30	30

Leakage Test (Specimen 1)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0.366
2	1000	0	0.427

Unlocking and Locking Pressure (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	40	40
2	40	40
3	40	40

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0
2	1000	0	0

Table 10-4. Functional Test Data Obtained at 1000 Cycles

Unlocking and Locking Pressure (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	30	30
2	30	30
3	30	30

Leakage Test (Specimen 1)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Locked Leakage, Piston Locked (scim)
1	750	0	0.549
2	1000	0	0.610

Unlocking and Locking Pressure (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	40	40
2	40	40
3	40	40

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0
2	1000	0	0

Table 10-5. Functional Test Data Obtained at 5000 Cycles

Unlocking and Locking Pressure (Specimen 1)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	50	50
2	50	50
3	50	50

Leakage Test (Specimen 1)

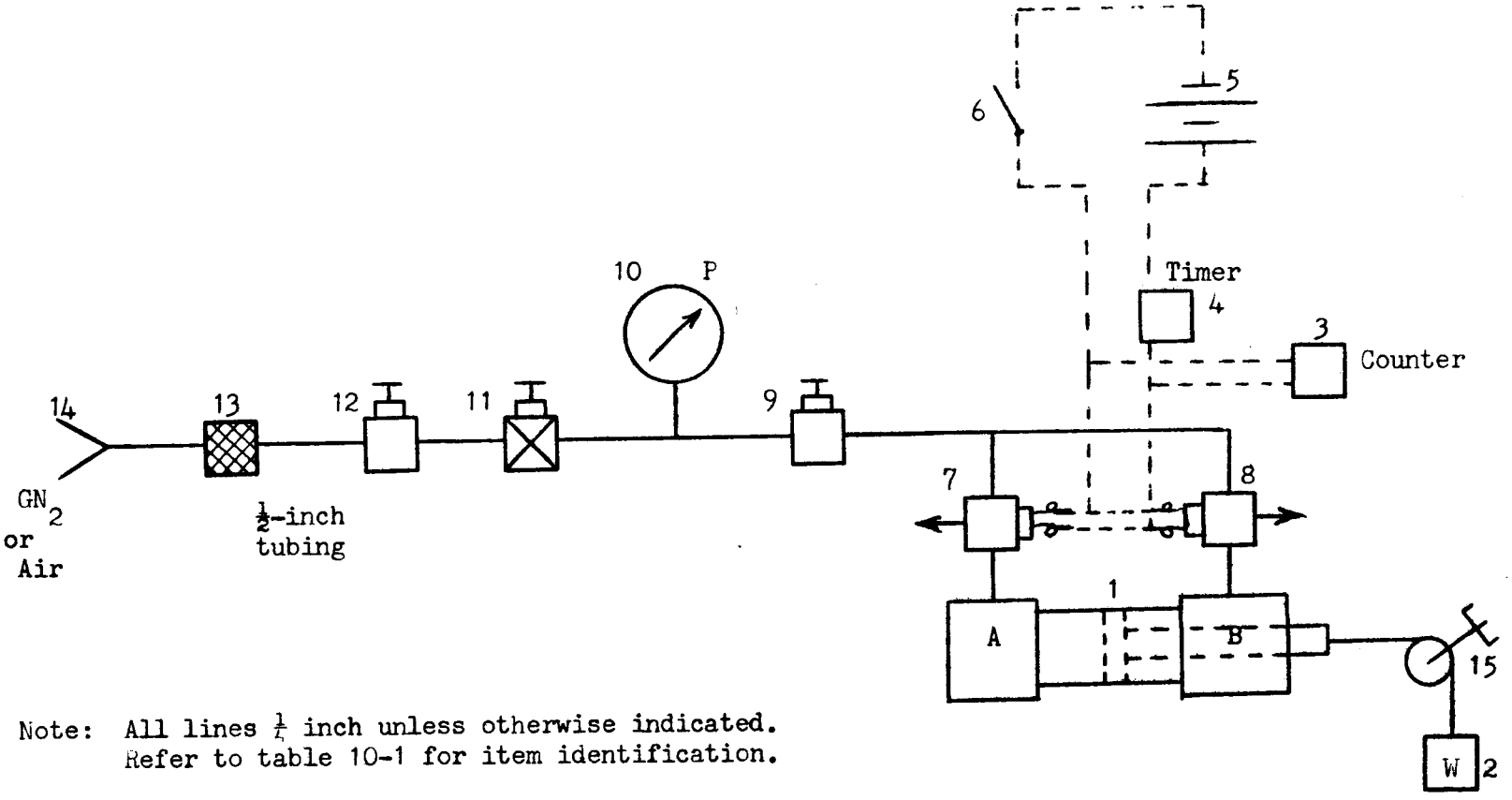
Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	0	0.366
2	1000	0	0.427

Unlocking and Locking Pressure (Specimen 2)

Run	Unlocking Pressure (psig)	Locking Pressure (psig)
1	30	30
2	30	30
3	30	30

Leakage Test (Specimen 2)

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)
1	750	3	0
2	1000	4.27	0



Note: All lines $\frac{1}{4}$ inch unless otherwise indicated.
Refer to table 10-1 for item identification.

Figure 10-1. Cycle Test Schematic

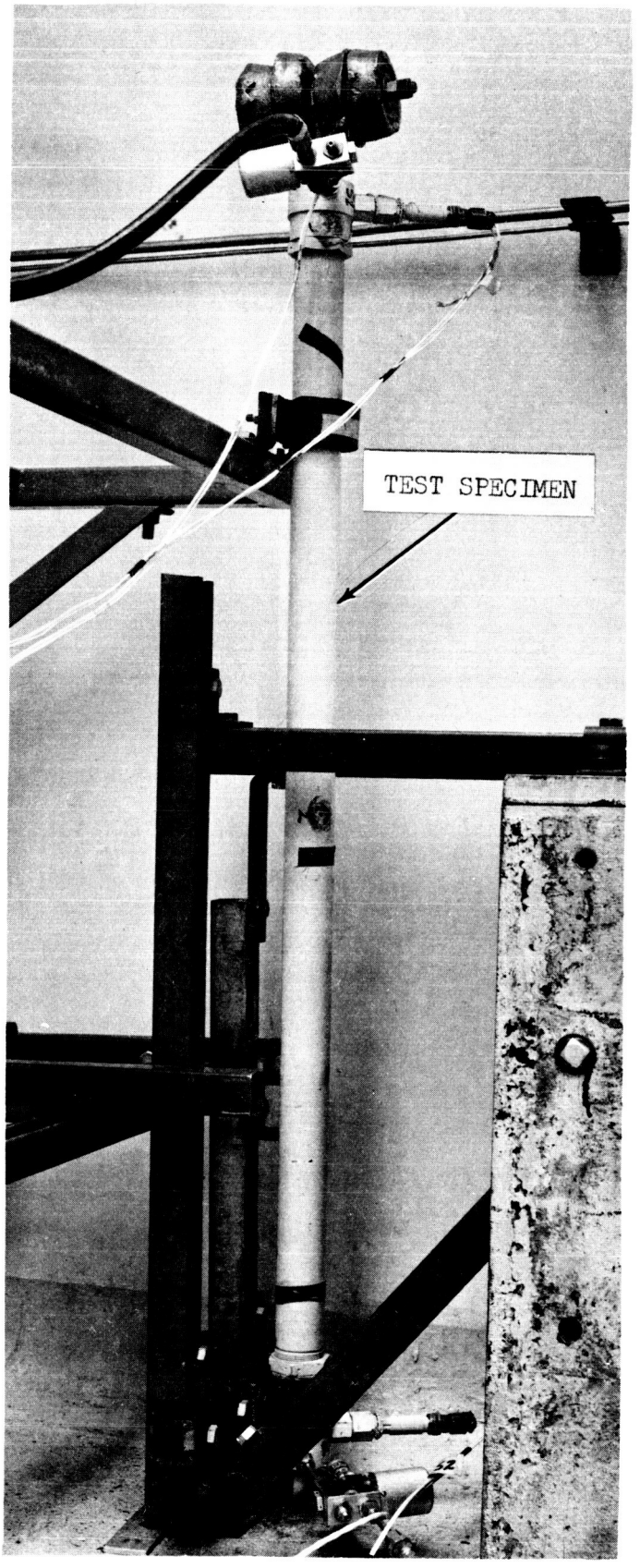


Figure 10-2. Cycle Test Setup

SECTION XI

SALT FOG TEST

11.1 TEST REQUIREMENTS

11.1.1 A salt fog spray test shall be performed on specimen 2. The test specimen shall be subjected to 240 (±2) hours of an atomized salt solution.

11.1.2 The solution shall contain five parts by weight of salt in 95 parts by weight of H_2O with no more than 200 parts per million of total solids. The specific gravity of the salt solution shall be from 1.023 to 1.037 with a reference temperature of 95 (+2, -4)°F. The salt solution shall also have a Ph value of 6.5 to 7.2. Diluted chemically pure (CP) hydrochloric acid or CP sodium hydroxide can be used to adjust the value of the Ph.

11.1.3 Following the 240-hour exposure, the test specimen shall be subjected to a functional test within 1 hour after returning to room ambient conditions.

11.2 TEST PROCEDURE

11.2.1 Prior to the salt fog test, the specimen was visually inspected for corrosion, dirt, and oily films. All unnecessary oil films and dirt particles were removed, and spots of corrosion were noted.

11.2.2 With the cylinder ports capped, the specimen was placed in the salt fog chamber as shown in figure 11-1 and listed in table 11-1. The chamber was adjusted to a temperature of 95°F so that the clean fog-collecting receptacle in the exposure zone could collect from 0.5 to 3 milliliters of solution per hour for 80 square centimeters of horizontal collecting area. This condition was maintained for 240 hours.

11.2.3 At the end of the 240-hour period, the test specimen was removed from the chamber and allowed to return to room ambient conditions.

11.2.4 One hour after returning the specimen to room ambient conditions, a functional test as specified in section IV was performed. All test data were recorded.

11.3 TEST RESULTS

11.3.1 The atomized salt solution and required temperature of 95°F were maintained for 240 hours.

11.3.2 The results were considered satisfactory.

11.3.3 The insulation resistance between all nonconnected terminals and between each terminal and the case was over 20 megohms.

11.4 TEST DATA

Functional test data recorded after the salt fog test are presented in table 11-2.

Table 11-1. Salt Fog Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	2	Pneumatic cylinder, double acting
2	Test Chamber, Salt Fog		NA	NA	

Table 11-2. Post-Salt Fog Test Functional Test Data

Unlocking and Locking Pressure			
Run	Unlocking Pressure (scim)	Locking Pressure (scim)	
1	30	30	
2	30	30	
3	30	30	

Leakage Test			
Run	Pressure (psig)	Leakage, Piston Unlocked	Leakage, Piston Locked (scim)
1	750	2.8	0.427
2	1000	2.87	0.427

SECTION XII

BURST TEST

12.1 TEST REQUIREMENTS

12.1.1 Specimen 2 shall be pressurized with H_2O to 4000 psig. The pressure shall be maintained for 5 minutes and the cylinder checked for leakage and distortion.

12.1.2 Pressurization of one specimen shall be continued until rupture occurs.

12.2 TEST PROCEDURE

12.2.1 The specimen was installed as shown in figures 12-1 and 12-2 utilizing the equipment listed in table 12-1.

12.2.2 It was determined that all connections were tight, gages were installed and operating properly, and that all valves were closed.

12.2.3 The extend and retract ports of the cylinder were hydrostatically pressurized simultaneously to 4000 psig for 5 minutes. The pressure was then vented and the specimen was checked for distortion.

12.2.4 The pressure to the specimen was increased until leakage occurred at 7700 psig. The leakage was located in the pressure switch assembly on the retract side of the cylinder. The pressure was again increased to 10,000 psig, at which time the test was discontinued. All test data were recorded.

12.3 TEST RESULTS

12.3.1 No visible leakage or distortion occurred at 4000 psig.

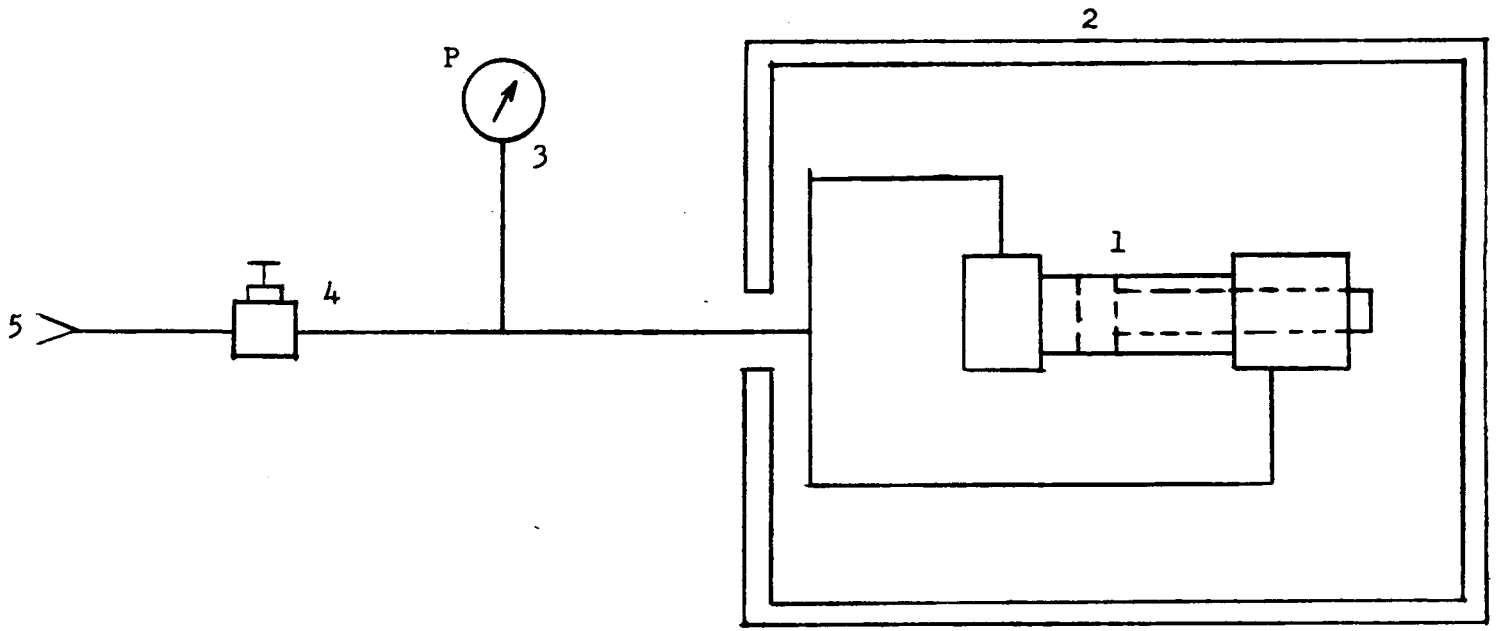
12.3.2 The test results were considered satisfactory.

12.4 TEST DATA

Leakage occurred at 7700 psig. Testing was continued to 10,000 psig and no distortion was evident.

Table 12-1. Burst Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Pneudraulics, Inc.	7091	0002	Pneumatic cylinder, double acting
2	Burst Chamber		NA	NA	
3	Pressure Gage (Hydrostatic)	Ashcroft	1850	NA	Variable 0-to 20,000-psig ±0.25% accuracy Cal. date 10-12-66
4	Hand Valve	Robbins Aviation	SSK 250-4T	NA	¼-inch
5	Hydrostatic Pressure Source	CCMD	NA	NA	Variable 0-to 20,000-psig



Note: All lines ¼ inch.
Refer to table 12-1 for item identification.

Figure 12-1. Burst Test Schematic

APPROVAL

TEST REPORT

FOR

PNEUMATIC CYLINDER, DOUBLE ACTING

Pneudraulics Inc., Model 7091

NASA Drawing Number 75M06911 Rev.D

SUBMITTED BY:

for Donald R Hardwick

T. M. Nelson
Test and Evaluation Section

APPROVALS

R. W. Claunch

R. W. Claunch
Program Supervisor

V. J. Venko

V. J. Venko, Director
Engineering Department

T. 24466

DATE: 6/22/67

PUBLICATION CHANGE

THE FOLLOWING CHANGES APPLY TO PUBLICATION: Technical Report

TITLE: PNEUMATIC CYLINDER, DOUBLE ACTING, Pneudraulics, Inc., Model 7091, NASA Drawing Number 75M06911, Rev. D.

NUMBER: TR-RE-CCSD-FO-1064-3 DATE: 12/19/66 BRANCH: Reliability Engineering

1. Throughout entire report:

   Delete "pressure switch" and substitute "position indicator switch".

PREPARED BY: D. Hardwick
D. R. Hardwick
Test and Evaluation Section

APPROVALS: R. W. Claunch
R. W. Claunch
Program Supervisor

V. J. Vehko
Director, Engineering Department

DISTRIBUTION SAME AS FOR ABOVE PUBLICATION

SPACE DIVISION CHRYSLER CORPORATION

DATE: 6/21/67

PUBLICATION CHANGE

THE FOLLOWING CHANGES APPLY TO PUBLICATION: Technical Report

TITLE: PNEUMATIC CYLINDER, DOUBLE ACTING, Pneudraulics, Inc., Model 7091, NASA Drawing Number 75M06911, Rev. D.

NUMBER: TR-RE-CCSD-FO-1064-3 DATE: 12/19/66 BRANCH: Reliability Engineering

1. Abstract:

   Following first sentence of last paragraph, add "New seals were of Buna N material."

2. Page XII, add to Test Summary as follows:

Low Temperature	1	5(+0,-4) °F	Determine if specimen is impaired by low temperature	Satisfactory	Test Completed

3. Page 5-2, paragraph 5.3.6:

   Add, "of Buna N material" following "with new piston seals".

DISTRIBUTION SAME AS FOR ABOVE PUBLICATION

SPACE DIVISION CHRYSLER CORPORATION

4. Add the following data as Table 5-2A, page 5-5A:

Table 5-2A. Functional Test Data Obtained at 5°F and 30°F
(Low Temperature Retest of Specimen 2)

Position Indicator Switch Indication			
Run	Unlock Pressure (psig)	Lock Pressure (psig)	Temperature (°F)
1	30	45	30
2	30	45	30
3	30	45	30
1	30	40	5
2	30	40	5
3	30	40	5

Leakage Test

Run	Pressure (psig)	Leakage, Piston Unlocked (scim)	Leakage, Piston Locked (scim)	Temperature (°F)
1	750	6.5	1.2	30
2	1000	10.5	1.3	30
1	750	8.5	14.5	5
2	1000	9.5	18.5	5

PREPARED BY:

D. R. Hardwick
Test and Evaluation Section

APPROVALS:

R. W. Claunch
Program Supervisor

V. J. Vehko
Director, Engineering Department